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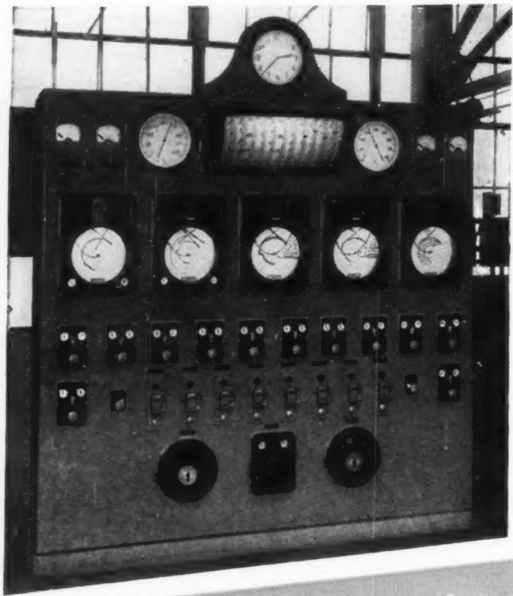
MECHANICAL ENGINEERING

ASME Diamond Jubilee Annual Meeting ◆ Chicago, Ill. ◆ November 13–18, 1955



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Spray nozzle of the unit injector . . .

. . . is shown pumping a fine spray of oil into a General Motors diesel-engine cylinder, where it is ignited by the heat of compression. This photo shows the fuel rushing out of the nozzle in beams of oil "fog" at 780 mph. The unit injector was exhibited recently at the General Motors Powerama in Chicago, Ill.

MECHANICAL ENGINEERING

October, 1955, Vol. 77, No. 10 ◆ George A. Stetson, *Editor*

Man and Nature

WEATHER along the eastern seaboard in the summer of 1955 was hot and humid week after week. Thousands of sweltering persons had reason to bless the late Willis H. Carrier, Honorary Member ASME, pioneer in air conditioning, whose papers before the Society in 1911 developed the theory and practical data on which that art is based.

Air conditioning, which Carrier defined as "positive production and control of desired atmospheric conditions within an enclosure, with respect to moisture, temperature, and purity," has grown tremendously and its applications have expanded from the industrial uses of forty-odd years ago, to the store, office, home, and bedroom.

Impressive and successful as man's attempts to control his weather environment "within an enclosure" have been, the summer of 1955, on the eastern seaboard, served also as a reminder of man's impotence in the face of hurricanes and sudden floods. Hundreds of readers of this magazine had personal experience of the devastation wrought by nature within the course of a few hours. Their energies are now being directed toward reconstruction of their towns, factories, and homes; and many are engaged in plans to prevent, or at least to reduce, damage from possible recurrence of such disasters in the future.

While engineers have learned much about flood control in many parts of the nation where larger drainage areas are encountered, it has been pointed out recently by W. W. Horner, chairman of the Engineers Joint Council Water Policy Panel, that "there is little or no information on the small bodies of water so characteristic of New England." He stated that this lack of information on New England rivers had been reported by Engineers Joint Council in 1951, and recommendations had been made "for the installation of more measuring devices in areas where an overabundance of uncontrolled water has been a spectacular problem occurring only at long intervals." He also cautioned against projects and devices which might prove unsound from an engineering point of view.

The northeastern states are heavily endowed with engineering talent, astute businessmen and industrialists, and civic-minded leaders. They are not likely to forget the summer of 1955 and the lessons taught them by the destruction caused by hurricane and floods, not the least of which is that man must work with nature—not against her.

The summer of 1955 will be remembered for another event which involved man and nature—the International "Atoms for Peace" Conference held in Geneva, Switzerland, August 8–20. Ten years after the destructive force of nuclear energy was let loose at Hiroshima, every nation active in the development of nuclear physics was represented at the Conference. Scientists and engineers who, for security reasons, had been working in secret with elaborate precautions to keep the information and techniques they had discovered from passing into the possession of unauthorized persons—in particular potential enemies—vied with one another to discuss and exhibit advances made in nonmilitary applications of this field of knowledge.

This magazine was fortunate in having its European correspondent present at the historic Geneva conference, and in being able to present his firsthand report. In addition to pictures of some of the exhibits we are also fortunate in being able to present on-the-spot photographs of many of the eminent scientists from all parts of the world who took part in scientific discussions. Here are the men, whose names are familiar to most engineers, who are working with nature in a new area of her mysteries for the benefit of their fellow men.

The provisions of the Atomic Energy Act of 1954 let loose a tremendous volume of results from scientific and engineering developments in nuclear physics, heretofore available only to limited groups. The impressive list of documents made public at Geneva and the generous flood of other technical papers there presented represent knowledge that will fertilize even more spectacular developments yet to come. There is no branch of engineering that will not have the course of its future development modified as a result of the useful applications of this new field of knowledge.

To assist engineers in the use of these new techniques The American Society of Mechanical Engineers organized a Nuclear Engineering Division early this year. And in co-operation with 23 other societies it will participate, under the sponsorship of the Engineers Joint Council, in a Nuclear Engineering and Science Congress, to be held at Cleveland, Ohio, Dec. 12–16, 1955. At present, preprints are being prepared of some 255 technical papers to be presented at the five-day Congress.

The year 1955 will stand as a milestone in man's progress in coping with the forces of nature.

Thread and Form Rolling

Process and machines for producing threads of uniform quality and applications

By Clifford T. Appleton

Vice-President, Reed Rolled Thread Die Co., Worcester, Mass.

The thread-rolling process is now recognized as a preferred method of producing threads of uniform quality and is more widely used today than at any time in its history. Although widespread knowledge of thread rolling is fairly recent, the process itself is not new as most of its fundamentals were known nearly 100 years ago.

Thread-Rolling Process

During World War II, the aircraft industry specified thread rolling as the preferred method of producing precise threads such as Classes 4 and 5. Today approximately two thirds of the external threading capacity in the United States is devoted to thread rolling.

Thread rolling is a simple cold-forging process confined almost entirely to external threads. The threaded faces of the dies are pressed against the periphery of a plain cylindrical blank and re-form the surface of the blank into threads as the blank rolls on the die faces. In penetrating the surface of the blank, the dies displace the material to form the roots of the thread and force the displaced material radially outward to form the crests of the thread. The blank has a diameter part way between the major and minor diameters of the thread.

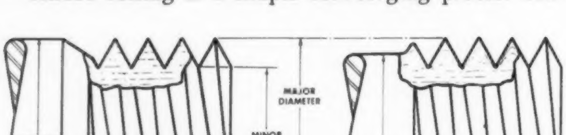

Fig. 1 Diagrammatic comparison of cut and rolled threads

A comparison of a cut and rolled thread is shown in Fig. 1. Unlike other threading processes, no material is removed and consequently no chips are produced. Rolled threads have increased strength, greater accuracy, and a high degree of surface finish. They are produced uniformly at high rates of production with no wasting of material.

Increased Strength. The cold forging that threads receive during the rolling process strengthens them in tension, shear, and fatigue. The fibers of the material are not severed as they are in other methods of thread production, but are re-formed in continuous unbroken lines following the contours of the threads, as in any good forging, as shown in Fig. 2.

Rolling between smooth dies leaves the thread with smooth burnished roots and flanks, free from tears, chatter, or cutter marks that can serve as focal points of stress and, therefore, starting points for fatigue failures. Improved fatigue strength is reported to be on the order of 50 to 75 per cent. On heat-treated bolts, from 36 to 40 Rockwell C hardness, that have the threads rolled after heat-treatment, tests show increased fatigue strength of 5 to 10 times that of cut threads.

Material Savings. Where blanks are prepared by heading, extruding, or stamping, or where the thread is the largest diameter on the part, as in the case of a stud, rolling will save material. This results in savings ranging from about 16 per cent on larger-diameter threads to over 27 per cent on smaller-diameter threads. On stampings, the thickness of metal from which the stamping is made can often be reduced. This also reduces the weight of the scrap strip or sheet from which a stamping is made.

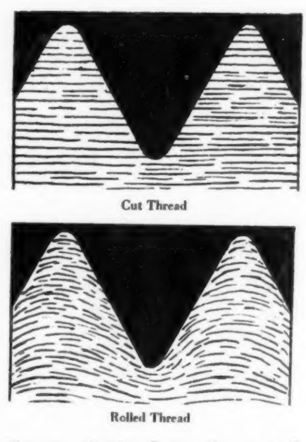

Fig. 2 Grain flow of cut and rolled threads

Accuracy and Uniformity. The production of accurate threads normally requires that close control be exercised over pitch diameter, thread angle, lead, taper, roundness, and drunkenness.

The thread angle produced on the work is dependent

Contributed by the Production Engineering Division and presented at the Diamond Jubilee Semi-Annual Meeting, Boston, Mass., June 19–23, 1955, of The American Society of Mechanical Engineers. Based on ASME Paper 55—SA-7.

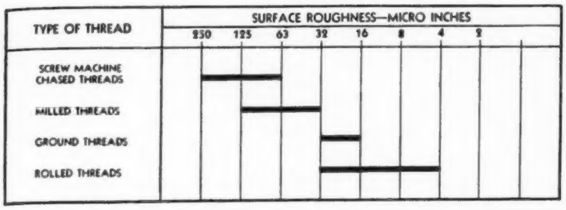

Fig. 3 Comparison of four common styles of thread finishes

upon the accuracy of the thread-rolling dies, while the accuracy of the lead produced is dependent upon the accuracy of the dies and the material being rolled. It is inherently easier to achieve accuracy on pitch diameter, thread angle, lead, and taper by rolling than by other processes and to maintain that accuracy over long periods.

The thread form of a set of thread-rolling dies is reproduced faithfully on the parts and does not change appreciably during the entire life of the dies. Thread-rolling dies do not wear out in the same manner as do other threading tools. Wear, instead of being concentrated on a sharp cutting edge, is distributed over a broad surface, and the rolling action is relatively free from friction. Therefore the thread form of a rolling die is not changed by erosion, nor does it fail to reproduce itself because of dullness or adhesion. It cannot be altered by improper sharpening, as sharpening is never required.

Smooth Finish. Threads produced by rolling are ordinarily smoother than the dies or rolls. This improvement is accounted for by the slight slipping and burnishing that the thread always receives as it rolls against the dies. A comparison of thread finishes commonly produced by the various threading methods is shown in Fig. 3.

Speed and Economy. Rolling has long been conceded to be the fastest method of producing threads. Although it is generally appreciated that thread rolling has proved economical on large-quantity production, similar savings and economies are realized on small-lot production.

Threads may be rolled on automatic screw machines without reducing spindle speeds, and the fact that rolling can be done on the collet end of the part behind a shoulder often saves a secondary threading operation.

As thread-rolling dies do not require sharpening, down time is reduced and sharpening and resetting labor is saved. The uniformity of the threads produced by thread rolling eliminates costly inspection.

Versatility of Application. Thread rolling is a versatile process capable of forming a wide variety of threads on many different materials and, in addition, capable of performing several nonthreading operations. Examples of the versatility of application are shown in Figs. 4 through 6.

Preferred Forms for Rolling. Whenever a material is penetrated by a thread-rolling die, a volume of the material is re-formed permanently. American Standard and similar thread forms with narrow root flats roll easily. When rolling threads or other forms with wide root flats, it is desirable, where possible, either to round the edges of the root flat with as generous a radius as possible, or design the thread with a full-radius root. Threads for lag screws, wood screws, and tapping screws have wide root flats and usually are rolled with flat dies specially designed to start the penetration with a narrow

Fig. 4 Parts with straight and gimlet-point threads, knurling, and other rolled forms

Fig. 5 Component parts with precision threads, serrations, grooves, and burnished surfaces

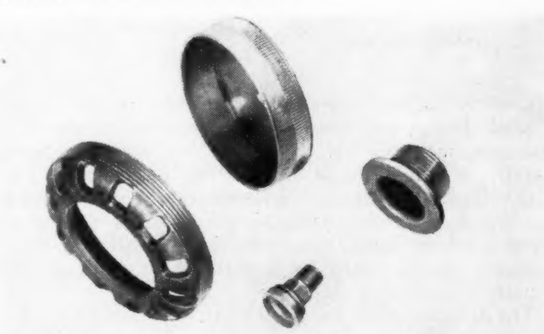

Fig. 6 Metal stampings made with rolled threads and forms

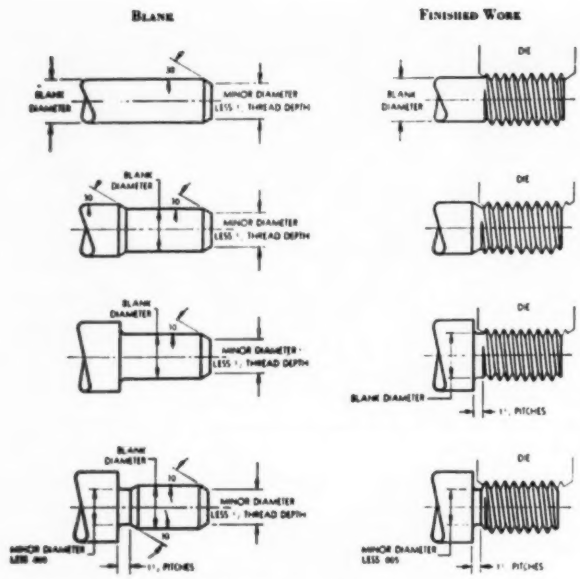

Fig. 7 The ends of the blanks should always be beveled

Fig. 8 Flat dies for reciprocating thread-rolling machines

flat, and then gradually enlarge the width of flat to size.

Blank Design and Specifications. Blanks for common fasteners, such as bolts, cap screws, and machine screws usually are cold-forged in heading machines. Close blank-diameter tolerances are maintained with carbide heading dies. Many parts are prepared for rolling on screw machines with the use of shaving tools. For very accurate threads with high hardness, the blanks are usually centerless-ground.

The design of blanks varies for different kinds of work as shown in Fig. 7. The ends of the blanks should be beveled to prevent excessive chipping of the threads on the dies or rolls. The angle and depth of bevel are important. A bevel of 30 deg from the axis of the blank, which gives 60 deg included angle, is preferred for general conditions. The diameter at the small end of the bevel should be less than the minor diameter of the thread.

In general, blank diameters should be less than the maximum pitch diameter of the thread and blank-diameter tolerances should be as small as practical for economical manufacture. On shorter thread lengths, especially with very soft materials, there is some endwise stretching of the blank. To offset this and obtain sufficient radial displacement of the material it is necessary to increase the blank diameter to compensate for the endwise stretching.

Since rolling does not remove or compress material, it is necessary that the blank does not contain more than the correct amount of material to form the finished thread. Also, the dies should be set up so they will roll maximum major and pitch diameters when using a maximum diameter blank. Otherwise, the blank will be overrolled, the dies will become overloaded, and the die life reduced.

Blank-diameter tolerances are controlled according to the accuracy of the thread to be produced. The importance of proper preparation of blanks cannot be overemphasized.

Thread-Rolling Dies and Thread Rolls

The general specifications of the dies and thread rolls are dependent upon the equipment selected for the job,

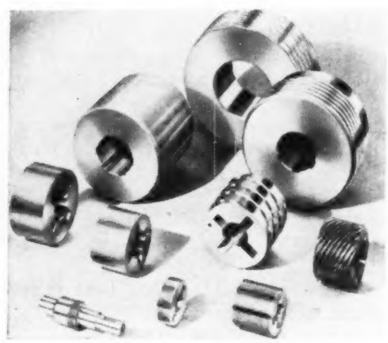

Fig. 9 Cylindrical dies for cylindrical-die thread-rolling machines

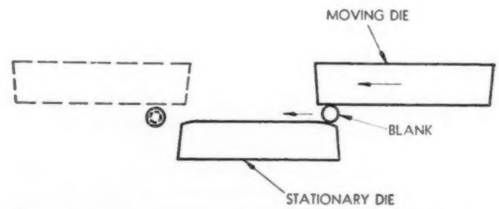

Fig. 10 Reciprocating thread-rolling machines use two dies with rolling faces opposite each other

and their design is determined according to the method of processing and the specific details of the work. Illustrations of various designs of flat and cylindrical dies are shown in Figs. 8 and 9. Under ordinary conditions each thread diameter and pitch requires a set of dies made especially for the diameter and pitch specified. The same dies are not recommended for different diameters of the same pitch.

The width of face on a die or thread roll is very important. The proper face width and the correct bevels on the dies not only prevent chipping of the end threads or

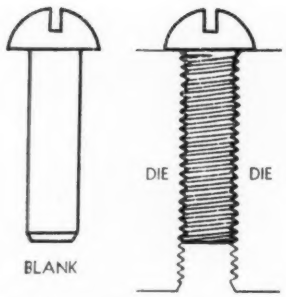

Fig. 11 Rolling threads on machine and cap screws

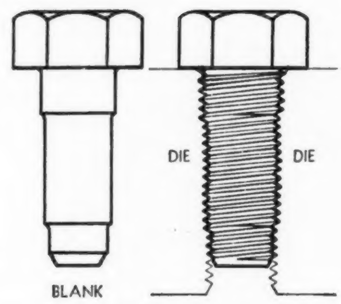

Fig. 12 Rolling multistep threads

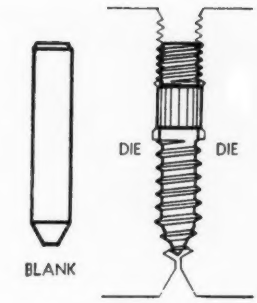

Fig. 13 Rolling-machine screw and gimlet-point threads and knurling

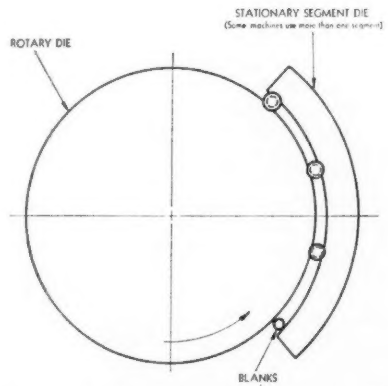

Fig. 14 Rotary-type planetary machines use rotating die and stationary segment die

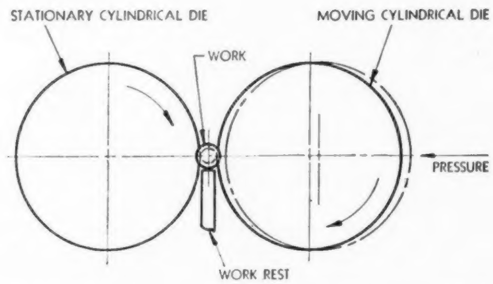

Fig. 15 Cylindrical-die thread-rolling machine—2-die type

breakage in the dies, but determine the number of settings possible for rolling on the face of the die. The width of the die face for in-feed rolling always must be greater than the length of thread to be rolled.

Equipment and Applications

Most of the threads produced today are rolled on thread-rolling machines and automatic screw machines. The thread-rolling machines use flat and cylindrical dies, while the automatic screw machines use cylindrical thread rolls. In most instances the entire length of thread is formed by the in-feed method. Through-feeding is used on cylindrical-die machines for continuous threading of long bars and short headless parts. End-feeding thread-rolling attachments are also used for through-feeding of longer threads.

Reciprocating (Flat Die) Machines. Flat dies are used in reciprocating types of thread rollers, including bolt-maker machines. The machines are made in a number of sizes, each for a limited diameter range and with a specified length of die. Two dies are used—one stationary and one moving—and the rolling faces of the dies are located opposite each other as shown in Fig. 10. A thread is rolled on one blank at a time during the forward stroke of the machine.

The number of revolutions provided for rolling a thread on a blank is dependent upon the die length, and the rate of penetration is determined by the shape of the die. The largest-size threads rolled on common types of reciprocating machines approximate 1 in. Typical flat-die applications are shown in Figs. 11 through 13.

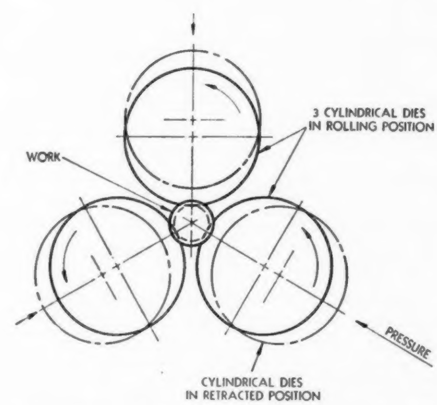

Fig. 16 Cylindrical die thread-rolling machine —3-die type

Rotary Planetary Machines. These recently developed machines have one central rotary die on a fixed axis and one or more stationary concave segment dies located at the outside of the rotary die as shown in Fig. 14. The starting end of the segment die is set so the segment and rotary dies will just contact the blank. The finishing end of the segment die is set closer to the axis of the rotary die so the thread is fully formed when the blank rolls past the finish end of the segment die. One or several blanks may be rolled in a segment die at one time,

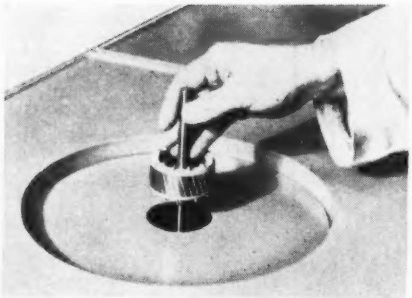

Fig. 17 Vertical-type cylindrical machine is easy to load

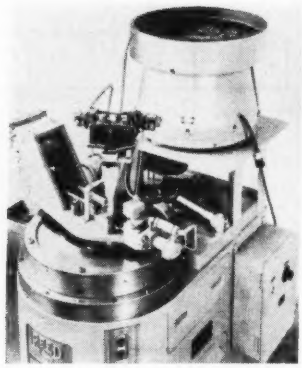

Fig. 18 Hopper feed for rolling double-end studs with different-size thread at each end

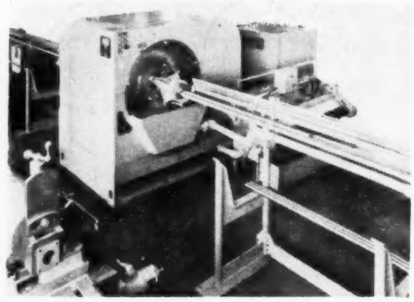

Fig. 19 Through-feed rolling of threaded bars, 20 ft long

dependent upon the setup. Each size machine has a specified length of segment die and the number of revolutions provided for rolling a thread on a blank is dependent upon the segment-die length.

Cylindrical-Die Machines. Cylindrical die machines have a wide range of speeds and feeds and are widely used for in-feed and through-feed rolling. Since the dies are circular in shape, there are no limitations on the number of revolutions provided for the rolling of a thread or the rate at which the dies feed into the work. Cylindrical-die machines are made with two or three dies and the three-die machines have diameter capacities exceeding 4 in.

Two cylindrical-die machines have two opposed dies mounted on parallel axes and the blank to be rolled is supported on a work rest between the dies as shown in Fig. 15. Three cylindrical-die machines have three dies equally spaced around the blank which floats between them as shown in Fig. 16. Figs. 17 through 19 show typical applications of three cylindrical-die machines.

Thread Rolling on Screw Machines

Rolling threads on screw machines and automatic lathes is most commonly done with attachments using one or two thread rolls. When rolling with one thread roll, the pressure is usually directly against the spindle and the blank. With two opposed rolls that form the thread between the rolls as they straddle the blank, the direct pressure on the spindle and blank is reduced to approximately 15 per cent of the pressure exerted by one roll.

With a single roll feeding directly toward the center of the blank, the size of the finished thread is controlled by the size of the blank and the final positioning of the cross slide. Attachments with two rolls usually have two opposed thread rolls which form the thread between the rolls as they straddle the blank—final size of the thread being obtained when the rolls are on the center of the work as shown in Fig. 20. The size of the finished thread is controlled by the size of the blank and by the fixed setting of the rolls in the attachment. The cross-slide travel is used only as a means of supplying movement to the rolls. Applications of the thread-rolling attachments are shown in Figs. 21 through 23.

In applying a thread-rolling attachment to a screw machine it is first necessary to decide on the cross-slide position for rolling, and in most cases the work and tooling arrangement determine this. However, there are preferred positions for thread rolling on different machines. An attachment also must fit within the confines of a tooling sector of an automatic. Sufficient cross-slide travel is required to withdraw the rolls from the center of the work to a position where the work will clear the outside of the rolls when it indexes from one station to the other.

In considering work revolutions and feeds, it is first necessary to determine the amount the thread rolls advance to complete the rolling after they first contact the work. This advance is the amount of cross-slide travel used in rolling the thread, and the rate of feed applied during the advance determines the number of work revolutions used in rolling the thread.

The spindle speeds are ordinarily the same as those for other operations and threads should be rolled with as few revolutions as possible. Suggested work revolutions are recommended by manufacturers of thread-rolling attachments and screw machines. Upon reaching full thread depth, the thread rolls should be withdrawn immediately from the work. The correct design and selection of cam are important. The ideal movement of the attachment during one revolution of the cam is to move the center of the rolls to the center line of the work at a predetermined feed per revolution, zero dwell at the center line of the work, and then instant rapid return. It is well to mention the importance of synchronizing the high point of the cam with the fast feed cycle of the machine during setup of the machine for rolling.

Rates of Production

Production rates vary with the nature of the work, hardness, and kind of material and the equipment used. The rate of production is usually less for harder materials and where the work is difficult and slow to handle. A comparison of the approximate production rates of the different types of thread-rolling machines is given in Table 1. The rates given apply to thread diameters of $^{1}/_{8}$ through 4 in. and for parts made of soft-carbon steels.

To secure the most satisfactory rolling conditions and die life, it is important that the proper type and size of equipment and the correct die speeds and number of blank revolutions be used. This is particularly true when close accuracy for roundness and size is required, especially on harder materials. Too many revolutions of the blank may have a tendency to work-harden some types of ma-

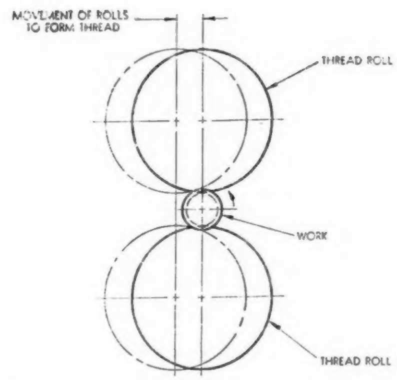

Fig. 20 Thread rolling in screw machine using two rolls

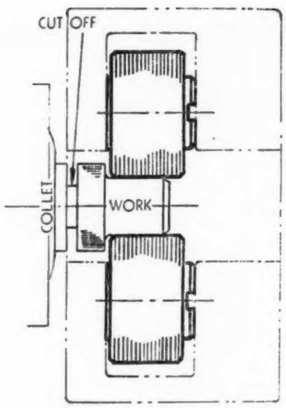

Fig. 21 Rolling straight threads on outboard end of work

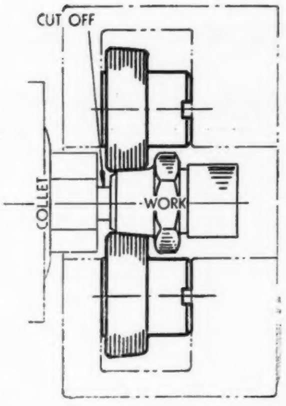

Fig. 22 Rolling taper pipe threads behind shoulder on collet end of work

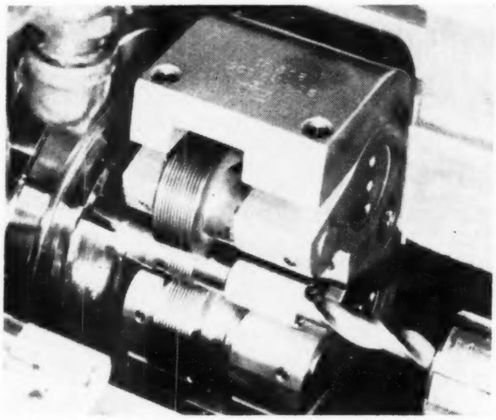

Fig. 23 Threads rolled behind shoulder as piece is drilled

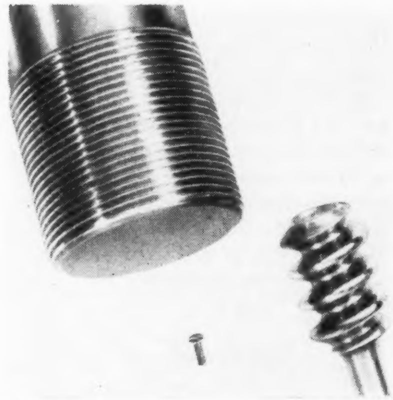

Fig. 24 Diameters from 0.060 to over 4 in. can be rolled with existing equipment. Threads range from 2 to 80 TPI.

Table 1 Comparative Production Rates on Thread-Rolling Machines for Soft Steel

(In-feed rolling-pieces per minute)

Thread diam, in.	Rotary planetary auto feed	Reciprocating Auto feed	Reciprocating Hand feed	Cylindrical die Auto feed	Cylindrical die Hand feed
1/8	400	175	60	40	21
3/16	to	150	.60	40	21
1/4	1200	125	60	40	21
3/8	150	100	60	33	26
1/2	150	80	60	33	26
5/8		70	50	33	21
3/4		60	40	33	21
1			30	21	16
1 1/2				16	11
2				16	6
2 1/2				11	6
3					4
4					4

terials, and thereby reduce the life of the dies. Rugged equipment with ample power is required to roll threads on heat-treated parts.

The shape of the rolling face and the setup of flat dies determine the amount of die penetration for each revolution of the blank. When using cylindrical dies or thread rolls, the rate of penetration is controlled by the amount of feed applied to the dies. Penetration rates vary for different equipment, kinds of work, and types and hardnesses of materials rolled.

Great Interest in Process

Diameters from 0.060 in. to over 4 in. can be rolled readily on existing equipment as shown in Fig. 24, and special equipment for both larger and smaller threads can be developed when required. Threads per inch ranging from 2 to 80 are being rolled, and dies for both finer and coarser threads can be produced.

The development of the thread-rolling process and thread-rolling equipment is by no means completed. On the contrary, there is more interest and activity in the process now than at any time in its history. New types of machines and attachments are being developed constantly, and the process daily is finding new applications where its speed, accuracy, and uniformity, and the strength that it adds to the parts rolled can be used to reduce costs and improve the quality of an endless number of threaded parts.

Europe's Competitive Challenge to American Productivity

By Frederick S. Blackall, Jr.[1]

Past-President of The American Society of Mechanical Engineers

The United States of America, in its commercial relationships with the other nations of the world, is to a certain extent on the horns of a dilemma. If we fail to remove those barriers which discourage the importation of goods from abroad, we shall encounter increasing difficulty in exporting our own products, unless, as we have been doing to the tune of billions of dollars in recent years, we wish to make a present to the rest of the world of the money with which to pay us for our exports. We must trade with the rest of the world—and by trade the reference is to a two-way process—or else retire to an isolated and insular position and attempt to become completely self-sustaining.

The problem is how to accomplish this without painful disruptions of important domestic industries, and the creation of serious, if temporary, unemployment conditions in the industries affected.

Some of the current discussion on the tariff question is based on the assumption that all we have to do to stimulate imports is to reduce tariffs. Much of it is prey to the fallacy that the U. S. is prospering at the expense of the rest of the world behind an unconscionable tariff wall; and nearly all of it displays complete ignorance of the revolutionary change which has taken place in U. S. tariff policy since the beginning of World War II.

International trade certainly needs to be re-established. However, we had international trade when our tariffs averaged something like four times what they do now. But a major difficulty today is that American industry is required by law to pay labor rates which are at least three to four times those paid by efficient European competition. Respecting, as I do, European engineering competence, I am sure that Europeans can manufacture just as rapidly in mass production as we can, once they are given the same quantities to work on. They well may have them, if they are given unrestricted access to our markets. If that should happen, it seems to me very possible that a lot of American workers in vital industries, the average profits of which are less than 10 per cent, may be thrown out of work, since the margin would not nearly cover the higher direct labor cost.

In attempting to resolve the problem, let us consider the case for maintenance of a reasonable protective tariff at somewhere near present levels.

Because of the lack of free convertibility of currencies in international trade and the devastation of Europe's productive mechanism by eight years of war, we have only just begun to feel the foreign competitive threat in our domestic markets.

Our lead over the rest of the world in mechanical efficiency is no longer the significant one which it was prior to Europe's postwar reconstruction. Germany today, for example, is probably operating with far more modern machinery, on the average, than we are.

Also, there is an awakening spirit of progress in the European management field, a breaking away from tradition, a search for new and better ideas, a willingness to learn from the other fellow.

Primarily, the fact that the United States has been able to outstrip the rest of the world in production and become the greatest industrial nation on earth is based on three factors: (*a*) A vast domestic market; (*b*) a recognition of the obsolescence factor through the constant renewal of outworn plant and equipment; (*c*) a widespread appreciation of efficient management techniques.

U. S.—A Low-Tariff Nation

There is still little understanding, either here or abroad, that successive reductions in U. S. tariffs during the past two decades have transformed us from a high-tariff nation into one of the lowest among the great industrial nations of the world. The average of our tariff rates is actually much lower than that of most of the trading nations, including Great Britain, which is frequently mentioned as a special target of our "infamous" tariff policy.

Let's look at some statistics. The average duty on all of our imports for the fiscal year 1951 was only 4.9 per cent, as compared with 25.6 per cent for the United Kingdom, 10.5 per cent for France, 8.6 per cent for Italy, 8.1 per cent for Switzerland, 7.4 per cent for Canada, and 5.8 per cent for Western Germany. The average for the fifteen leading countries of free Europe was 13.1 per cent.

Looking at it another way, U. S. customs collections in the old high-tariff days under the Hawley-Smoot Tariff Act represented 17.8 per cent of the value of all imports, including nondutiable items, and 53.2 per cent of the total value of dutiable goods alone, which were imported in 1931. By 1954, however, our tariffs had been reduced to such a degree that collections in the first nine months of that year amounted to only 5.1 per cent of the value of all imports for the period and only 11.6 per cent of the value of all dutiable goods brought in.

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These statistics would seem to lay to rest the old ghost that we are a high-tariff country. Now, while Europe has been berating us for high tariffs and demanding unrestricted nondutiable access to our markets, European nations have been raising their tariffs and surrounding their markets with all manner of import restrictions.

Tough Competition Ahead

We have reduced our tariffs through reciprocal agreements and otherwise by over 60 per cent. What will happen if we eliminate them altogether? We shall be facing unrestricted competition from manufacturers whose hourly labor rates, according to the U. S. Department of Labor, compared with ours in 1951, as follows: Great Britain, Scandinavia, Switzerland, and Czechoslovakia 25 to 37 per cent; France, Germany, Hungary, and Ireland, 19 to 24 per cent; Austria and The Netherlands, 13 to 18 per cent; Canada, 65 per cent.

The American Enterprise Association reports that wage rates in Japan are now 90 per cent below those of the United States; in the United Kingdom, Belgium, and France, 75 per cent below; in Sweden and New Zealand, 60 per cent below; in Canada, 20 per cent below our average labor rates.

Our labor costs are indeed high. To be sure, our productivity makes unit costs relatively low considering the wage base, but we have no patent on productivity. Given the same markets, Europe can produce in as low unit times as we can, and because of lower labor rates, can undersell us in circumstances where we cannot do very much about it. It seems reasonable to contend that our tariffs should be equalizers—not weapons with which to impair U. S. industry.

There is a grave danger that, if we permit the rest of the world to undersell U. S. manufacturers in their own markets, we may seriously injure substantial segments of U. S. industry.

It is time that we face the simple economic and mathematical facts involved in the foreign-trade problem. We need foreign trade, but we need a lot of other things too, including a wholesome and flourishing American industry. Let's try to get both without sacrificing the one for the other.

The Dollar Gap

The so-called dollar gap, or dollar shortage, which Europeans have grown accustomed to blaming on the United States in general and U. S. tariffs in particular, has been largely of Europe's own making rather than ours, if, indeed, we are to blame for it at all. U. S. imports actually have more than quadrupled in dollar value from prewar levels, having risen from about 2.4 billion dollars to nearly 11 billion dollars annually. However, the character of these imports has changed enormously. During the past two decades, the United States has become increasingly self-sufficient with respect to manufactured goods. Today, approximately 40 per cent of our foreign purchases are of basic materials and commodities, as against 20 per cent prewar. Technological advances likewise have exerted an important influence on the nature of our foreign requirements. It is apparent from the amazing growth of our total import business that there has been no real lack of availability of U. S. dollars to foreign nations. We not only have bought their goods, but we have made a gift to them of billions of dollars to tide them over the period when they could not produce the necessities of life for themselves. It is what they have done with these dollars which has created the real dollar gap.

The Sterling Block

By creating embargoes and rendering currencies noncovertible, Western Europe, after the war and still, only to a lesser extent, has stimulated export trade within the Sterling area behind a wall which was a much more effective deterrent to U. S. competition within the Sterling area than the U. S. tariff wall has ever been.

Europe's great need is to put her own house in order; to develop an appreciation, comparable to that which characterizes American industry, of the necessity of reinvesting its depreciation allowances in equipment and keeping its plant abreast of the latest technological advances.

Finally, if the United Kingdom and Western Europe seriously wish to face the facts of economic life and not merely find in Uncle Sam a whipping post for problems of their own making, it is high time that they re-established the free convertibility of currencies, which is long overdue. They can do it easily if they really want to.

Arguments for Lowering Tariffs

The average man in the street has little comprehension of this important fact: We cannot export our own products unless we make the dollars available to foreign buyers with which to purchase them. There are relatively few ways in which we can provide these dollars and make available to foreign shippers what the experts call U.S. dollar exchange. The normal and historic way to do it is to purchase goods or services from them. Another way is to invest dollars in foreign projects. If we fail to do one of these two things, about the only way which remains is to give them the dollars, which is what we have been doing under the Marshall Plan. We cannot keep this up indefinitely. Most economists agree that it has already contributed substantially to a higher tax level in this country than is healthy for our economy.

It follows, then, that the restoration of trade between the rest of the world and this country is vital to the maintenance of our own exports. These, in turn, represent a surprisingly substantial portion of our gross national product. Some 4,376,000 workers were engaged in employment attributable to foreign trade in 1952. This is about 7 per cent of our total labor force. Another million and a quarter persons, or $2^1/_4$ per cent, are dependent upon imports for employment. Thus the maintenance of our export-import trade is essential to our own internal health.

Proponents of further tariff reduction admit that the average tariff rate has fallen greatly during the past 20 years and is lower than that of most other countries. They argue, however, that this is not competent evidence upon which to appraise the extent to which American tariffs actually exclude foreign products. Those duties which are so high as to prohibit imports almost completely do not affect the ratio, because little or no revenue is collected in such cases.

In support of this contention, the American Enterprise Association presents the following statistics:

"In 1951, 95 per cent of dutiable imports were subjected to tariffs of 30 per cent or less; the remaining 5 per cent paid rates greater than 30 per cent, thus showing how the high rates have restricted imports. Furthermore, in the same year, over 10 per cent of the tariff rates were above 50 per cent, and another 15 per cent of the tariff rates were between 30 and 50 per cent."

It is further argued that the average tariff on manufactures is far higher than the over-all average; the latter included large bulk commodities and many items which simply are not available within our borders. Thus, according to the adherents of liberalization, our tariff rates do tend to prevent the products of foreign labor from entering our markets on a competitive basis—and to a far greater extent than the over-all averages would indicate.

The classic argument for free trade is, of course, that the total output of all nations will be increased as each nation is encouraged to produce those items in which it is most efficient. Such a system, it is contended, provides more goods for more people at lower cost. Thus it raises the average standard of living for the people of all nations. Parenthetically, it must be recognized, however, that raising the over-all average standard may involve reducing the standard of living for some, while raising that of others. It seems reasonably clear whose standard would have to be sacrificed if this should occur, since ours is the highest in the world.

One of the most compelling arguments advanced in recent years for the reduction of tariffs is that we must keep our allies of the Free World economically strong and psychologically friendly toward us. Geographically small nations like England are dependent upon their exports, to a far greater extent than we are, to eat and survive. Barring their products from our markets weakens their economy, engenders resentment, and forces them to trade with our enemies, since they must sell their products in order to maintain their existence. This plays right into the hands of Russia, as happened recently when the Soviet made a large purchase of Italian almonds and then advertised that Americans were willing to take Italian sons, but not Italian goods.

The proponents of "Trade not Aid" contend that tariff reduction will be carried out under reciprocal arrangements. Thus it will serve to reduce or eliminate many of the higher foreign-tariff rates, import quotas, and embargoes which now seriously impede the export of U. S. products to overseas buyers.

To a large extent, these foreign barriers to our products have been erected in an effort to conserve the dollar position of European nations; if their dollar position could be strengthened in the historic and conventional manner by a freer interchange of goods among nations, these barriers would quickly melt away.

It is further contended, and with much justification, that the mal-distribution of the world's store of gold, and the industrial dollar exchange shortage in foreign nations constitute a continuous threat to the solidarity of the free world; that wars to a large extent spring from international economic inequalities and dislocations; and that almost any sacrifice within reason is justified if it will iron out these inequalities and thus serve the cause of peace.

Finally, it is argued, the maximum increment of business which could be secured by foreign sellers in the U. S. market will always be a small part of our total purchases. Considerations of distance, shipping time, service and repair, transport charges, and the like, are bound to assure the U. S. producer a long lead over his foreign competitor. Those who hold this view contend that the adverse effects upon U. S. employment by the sum total of imports which would be engendered by a less restricted tariff policy would be of no important significance.

So there are the two positions: the case for the defense; the case for the prosecution. What conclusions can we draw from this titanic struggle of opposing forces?

The Author Concludes—

We do need some tariff protection in this country if we are going to maintain our standard of living. We can have reasonable protection and still stimulate foreign trade if we'll all take the broad view and not press needlessly for protective advantage, recognizing, as we must, that the solidarity of the Free World is one of the stark necessities of our era. It is the extremists in both camps whom we have to fear. Let's take the middle course where, to a certain extent, we can have our cake and eat it, too.

Meeting the Challenge

Whether we reduce our tariffs or not, European producers are determined to capture an increasing share of the world's markets. Every one of them has his sights set on the richest of the world's markets—that of the U.S.A. Although they rant and rave about our tariff wall, they know that they must face it. So they have been working hard to get their costs of production down to a point where they can enter our markets, tariff or no. Make no mistake. We should not underestimate the competitive threat—it is already here.

Thus one of our major tasks is to increase the productivity of our workers by developing and applying the best possible tools for production and providing the power to operate them in the cheapest, most efficient manner. Better processes, improved design and equipment, and cost reduction are paramount necessities if we are to maintain our industrial leadership.

We must resign ourselves, also, to the loss of a portion of many export markets in which we were formerly preeminent.

U. S. customs regulations must be simplified and made crystal clear, so that a foreign exporter of goods to our markets will know in advance exactly how his product is going to be classified, valued, and assessed.

Certainly, too, our tariffs should be scrutinized with a view to eliminating needless differentials. If a U. S. manufacturer requires only a 15 per cent protective tariff, to remain competitive, anything beyond that becomes a subsidy and should be eliminated. On the other hand, American industries which are vital to our economic welfare and national security should not be subjected to destructive price competition from foreign producers whose labor rates are not subject to our high and rigid standards.

Zirconium—

Fabrication Techniques and Alloy Development

By C. E. Lacy[1] and J. H. Keeler[2]

The fabrication techniques by which zirconium and its alloys have been made successfully into various product forms are described. The neutron-absorption characteristics, mechanical properties, and corrosion resistance of zirconium and some zirconium alloys are discussed.

Recently, the technology and large-scale production of ductile zirconium metal has undergone a rapid development because of interest in this metal for nuclear-reactor applications. Zirconium has a combination of properties which particularly suit it for use as a structural material in nuclear reactors. These include a tendency to absorb relatively few neutrons, a high melting point, fair strength, and good corrosion resistance in water and liquid metals.

A measure of the suitability of a metal for use as a reactor structural material may be obtained by dividing its absorption tendency per unit volume by its yield strength per unit area. This ratio of volume absorption per unit strength should be as low as possible for reactor application. Values of this ratio for a few common alloys are given in Table 1. Zirconium is clearly better than the iron and aluminum alloys; other common metals would have higher ratios than aluminum. The use of alloy additions to strengthen zirconium makes its position even more favorable.

Table 1 Comparison of Volume Neutron Absorption Per Unit Strength of Zirconium With Other Common Alloys

Material	Volume neutron absorption per unit strength ratio[a]	Value of ratio relative to zirconium
Type 347 stainless steel	7.70	29.6
1035 steel	5.25	20.2
2S-O aluminum	2.66	10.2
24S-T aluminum	0.42	1.6
Zirconium	0.26	1.0

$$^a\ \text{Ratio} = \frac{\dfrac{\text{thermal neutron cross section (barns)}^b}{\text{cc}}}{\text{yield strength (psi) at 70 F}} \times 10^{-18}$$

[b] The tendency of an element to absorb neutrons is expressed in terms of cross section (units are barns per atom = 10^{-24} cm^2) which is a measure of the probability that the atoms will capture neutrons.

With regard to both processing and properties, zirconium is similar to its sister metal, titanium. The mechanical properties of zirconium are intermediate to those of aluminum and mild steel; corrosion-wise zirconium is better than aluminum and iron, but not as good as stainless steel for certain reactor applications.

Zirconium metal, like titanium, is produced by the Kroll process, in which the tetrachloride is reduced with magnesium. Hafnium, generally associated with zirconium, has a great tendency to absorb neutrons; hence this element is chemically removed from reactor zirconium prior to the reduction step. The sponge product of the reduction step may be vacuum-melted in graphite crucibles but it is generally arc-melted. Zirconium sponge can be further purified prior to melting by the iodide or hot-wire process which yields a product termed crystal bar.

Arc-melted zirconium ingots have been fabricated successfully into most of the standard metal shapes, including plate, sheet, rod, wire, and tubing.

Fabrication of Zirconium

General. In the fabrication of zirconium, there are some general considerations which must be taken into account. These include the purity or composition of the zirconium being fabricated, the tendency of zirconium to react with gases at elevated temperatures, and its tendency to gall under sliding contact with other metals.

Three kinds of zirconium ingot are commonly prepared; arc-melted iodide or crystal-bar metal, arc-melted sponge, and graphite-melted sponge; the impurity content and hardness of these ingots increase in the order of listing. The variations in composition have only a minor effect on hot-working behavior, but cold-working operations become more limited and more frequent anneals are required as the hardness increases. The addition of alloying elements will restrict cold-working operations in the same manner as impurities and also necessitate changes in the hot-working conditions.

Zirconium reacts with the gases oxygen, nitrogen, and hydrogen at elevated temperatures with resulting embrittlement. Knowledge of this behavior is important in hot-working and annealing operations. Zirconium in heavy sections may be heated in oil, gas, or muffle furnaces and hot-worked in air since, for moderate heating times, the contaminated layer will be only a few mils thick and can be removed later by machining. Time at temperature for such operations must be kept to a minimum. Inert-gas furnace atmospheres, salt-bath heating, and copper or mild-steel jackets are frequently used to reduce contamination during hot-working. Heating in atmospheres containing hydrogen should be avoided since small amounts of hydrogen cause serious embrittle-

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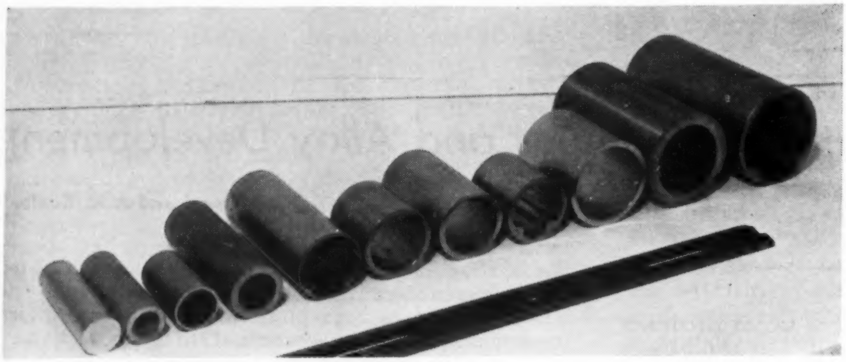


Fig. 1 Zirconium sections extruded from copper-jacketed billets

ment under certain conditions of heat-treatment. Hot-working temperatures range from 1100 to 1825 F; the temperature is raised toward the high end of the range as the size and strength of the material being worked are increased.

Short-cycle heating in air can be used for annealing zirconium during cold-working if the section thickness is such that a thin contaminated layer will not affect its usefulness or if the contaminated zone can be removed. However, the use of vacuum-annealing is preferred for insuring good-quality cold-finished products, and it is essential for thin sections. Cold reductions of 25 to 60 per cent are used between anneals, the amount depending on the hardness of the material. Annealing temperatures range from 1000 to 1550 F, with the higher temperatures being used for shorter heating times and for alloys.

Hot-Working. Zirconium ingots are produced in sizes from $2^1/_2$ to 12 in. diam with ingot weights ranging from 10 to 500 lb. Initial hot-working of the larger ingots has been done by forging; the smaller ingots have been worked initially by forging, rolling, or extrusion.

Slabs or round billets can be forged readily from the ingots on either press or hammer-forging equipment. Strip and plate with thicknesses of $^3/_{16}$ in. and greater can be hot-rolled from both small ingots and forged slabs.

Rod can be hot-rolled from small ingots and forged billets in grooved rolls. Slabs and bars have not been fabricated from large ingots by grooved rolling because the ingot length and quantities of material involved make forging more practical.

Rod and tubing are widely produced by extrusion and in a few cases special shapes have been extruded successfully. To date these products have been extruded from ingots and forged billets 2 to 7 in. diam using reduction ratios of 10 to 1 to 100 to 1. Good surface quality in the extruded product is the principal problem in the extrusion of zirconium. Because zirconium tends to stick to the die with resultant galling, special lubricants are required to give a satisfactory surface. Molten glass, i.e., the Ugine-Sejournet process, and copper jackets are used for this purpose; however, copper has been more widely applied than glass. Sections of tubing and rod extruded from copper-jacketed billets are shown in Fig. 1. In extruding tubing to date, center holes in the billets have been made by machining. Recently, zirconium cylinders have been pierced successfully in a closed-end die using glass lubrication. When perfected, piercing should result in considerable savings in the preparation of billets for the extrusion of tubing.

Cold Fabrication. Flat products, sheet, strip, and foil, are easily fabricated from zirconium by cold-rolling. Crystal-bar zirconium and good-quality sponge zirconium plate can be cold-rolled from $^1/_4$ to 0.001-in-thick foil without intermediate anneals. However, to minimize edge-cracking and preferred orientation, intermediate anneals are normally used.

Cold-finished rods from $^1/_4$ to about $^3/_4$ in. diam are fabricated by cold-rolling or cold-swaging larger hot-worked rods. Occasionally, rods have been cold-finished by drawing, but for small quantities swaging is preferred because the lubrication problem in drawing is avoided.

Wire can be prepared from zirconium by cold-swaging and by cold-drawing. In drawing zirconium, special lubrication techniques are required to prevent die seizure and resultant galling. Either of two methods is used, special lubricants such as a lacquer-molybdenum disulphide mixture or a special base such as an oxide or phosphate coating plus more conventional lubricants. The obtaining of good surface quality in the drawn wire is a problem because of the lubrication difficulties. Swaging, although tedious, produces wire with good surface quality and eliminates lubrication problems; hence it is preferred for small quantities of wire larger than 0.030 in. diam.

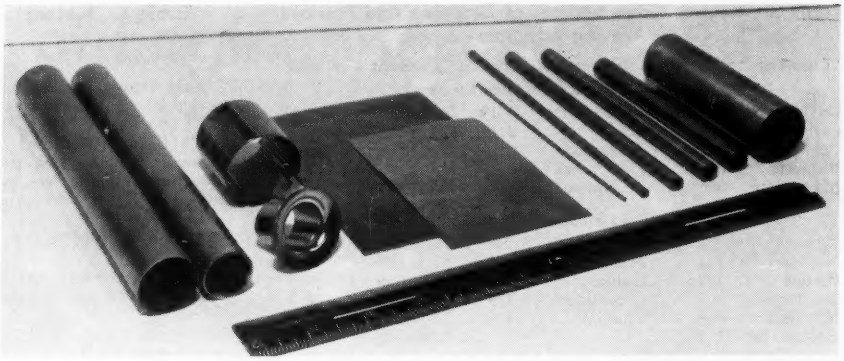
Seamless zirconium tubing can be cold-finished from extruded starting tubes by tube reducing, drawing, and a combination of the two methods. Starting tubes from $^7/_8$ to $2^1/_2$ in. diam can be successfully tube-reduced using conventional tooling. Zirconium tubes with internal ribs parallel to the tube axis can be fabricated by tube-reducing over a grooved mandrel; however, a ribbed starting tube is required to yield a sound product.

Tubing as small as 0.080 in. diam $\times$ 0.010 in. wall can be cold-drawn from extruded and tube-reduced or extruded starting tubes. Tube-drawing of zirconium, like wire-drawing, is difficult because of the die-seizure problem. The largest quantity of tubing has been drawn using a phosphate coating and conventional lubricants. A few attempts have been made to draw large-diameter thin-walled tubing. With sponge zirconium, 20-mil wall is about the minimum that can be achieved at tubing diameters of 1 to $1^1/_2$ in.

Welded zirconium tubing can be produced from strip by roll-forming and inert-arc welding. Tubing $^1/_2$ to $1^1/_2$ in. diam has been fabricated on continuous mills of this type.

Other types of cold-forming operations which have been applied to zirconium include deep-drawing, impact extrusion, bending, flanging, shearing, slitting, and blanking.

Fig. 2 Cold-finished zirconium products. (*Left* to *right:* Deep-drawn thimble, tube-reduced tubing, flanged tube, roll-formed tube, 0.035-in. sheet, 0.0002-in. foil, six sizes of cold-drawn tubing.)



Zirconium samples, cold-finished by several different techniques are shown in Fig. 2.

Machining. Zirconium may be machined by all of the standard operations. Its general machining characteristics are similar to those of titanium. It has tendency to gall. Therefore tools must be kept sharp, and light and interrupted cutting should be avoided.

Welding and Brazing. Zirconium is easily welded by the inert-arc technique. Sound welds are obtained by inert-arc welding in air, but to obtain welds with best ductility and optimum corrosion resistance, welding in a gastight box with a highly purified inert gas is desirable. Most of the welding experience to date has been on material up to about $^1/_4$ in. thick.

Resistance-spot and resistance-seam welds also can be used successfully to join zirconium sheet.

Under proper conditions, zirconium can be brazed and soldered.

Alloy Development

Properties of Unalloyed Zirconium. High-purity or crystal-bar zirconium is weaker, more ductile, and more corrosion-resistant than sponge zirconium although the difference in properties has greatly decreased with improvements in processing and purity of the sponge. The tensile properties of the two kinds of zirconium are given in Table 2. The strength of zirconium has been

Table 2 Room-Temperature Mechanical Properties of Annealed Zirconium

Property	Crystal-bar zirconium	Sponge zirconium
Ult. ten. strength, psi	24000-43000	42000-62000
0.2% offset Y S, psi	7700-26000	25000-38000
Elongation, per cent	24-54	23-40
Reduction in area, per cent	25-75	27-60
Modulus of elasticity, psi	$13.1-13.9 \times 10^6$	$13.6-14 \times 10^6$
Hardness, VHN	73-130	120-160
Charpy impact str., ft-lb	2.5-75	14-16

shown to increase with decreasing grain size, increasing strain rate, increasing preferred orientation, and increasing strain. The strength of unalloyed zirconium drops off rapidly with increasing temperature.

The impact strength of zirconium is influenced by impurities; when impurities are kept at a low level, zirconium remains ductile to very low temperatures. Resistance to impact is also affected by preferred orientation. It has been shown that the low-temperature impact strength is influenced by notch orientation.

Unalloyed zirconium, either crystal-bar or sponge materials, is not very resistant to deformation by creep. A secondary creep rate of 1 per cent in 1000 hr is to be encountered for a stress of 49,900 psi at room temperature and minimum creep rates of 8×10^{-5} to 4×10^{-3} hr are obtained for stresses of 7000 to 10,000 psi at 932 F.

The most significant aspect of the creep behavior of unalloyed zirconium is the relatively large amount of "instantaneous" creep strain that occurs as the load is applied. Once the load is applied and this early strain is obtained, the rate of extension is very small. The creep behavior of unalloyed zirconium is also very sensitive to stress. A decrease of only a few thousand pounds per sq in. increases the rupture life from a few hours to greater than a thousand hours.

The corrosion of unalloyed zirconium is characterized by a period wherein the corrosion rate is low, followed by a period of more rapid corrosion. The length of the initial period of low corrosion rate depends strongly on impurities and surface condition.

The initial period of the reaction between zirconium and water at elevated temperature can be described by the equation

$$\Delta m = kt^n$$

where Δm is the weight gain, t is the time, and k and n are constants. During the initial period when n is less than $^1/_2$, a thin black or colored adherent film forms on the zirconium, providing some protection. Later a white, nonadherent corrosion product begins to form, and the new rate law is believed to be linear ($n = 1$).

Properties of Alloyed Zirconium. The purpose of alloying zirconium is to obtain improved elevated-temperature strength and corrosion-resistance while maintaining low neutron absorption. Neutron absorption is predictable as this is a function of the atoms themselves and to maintain low neutron absorption, it is only necessary to avoid alloying with elements having a high neutron absorption. See Table 3.

Since zirconium has such a comparatively large atom size there are few opportunities for solid-solution strengthening. This means that with the exception of a small number of elements (O, N, Ti, Hf, Nb, Sn, and Al) strengthening is obtained through the presence of particles of a second phase, usually a compound of zirconium and the element added.

The design of zirconium alloys with high strength at elevated temperatures is complicated by the dimensional and mechanical instability associated with the transformation of zirconium from the hexagonal-close-

Table 3 Neutron Cross Sections of Zirconium and Possible Alloying Additions

Element	Barns	Element	Barns	Element	Barns
Low Cross Section (Less than 1.0 barn)					
Oxygen	0.0002	Silicon	0.13	Hydrogen	0.33
Carbon	0.0045	Lead	0.17	Calcium	0.43
Beryllium	0.009	Zirconium	0.18	Sodium	0.49
Bismuth	0.032	Phosphorus	0.19	Sulphur	0.49
Magnesium	0.059	Aluminum	0.22	Tin	0.65
Medium Cross Section (1.0 to 10.0 barns)					
Zinc	1.1	Iron	2.4	Copper	3.6
Niobium	1.1	Molybdenum	2.4	Nickel	4.5
Barium	1.2	Gallium	2.7	Tellurium	4.5
Strontium	1.2	Chromium	2.9	Vanadium	4.7
Nitrogen	1.8	Thallium	3.3	Titanium	5.6
Germanium	2.3			Antimony	6.4
Large Cross Section (Greater than 10 barns)					
Manganese	13	Silver	60	Iridium	440
Tungsten	19	Lithium	67	Boron	750
Tantalum	21	Gold	94	Cadmium	2400
Chlorine	32	Hafnium	115	Samarium	6500
Cobalt	35	Mercury	380	Gadolinium	44000

packed phase to a body-centered-cubic structure at approximately 1585 F. This transformaton limits the maximum useful temperature of zirconium and its alloys. Most elements either lower or do not appreciably affect the transformation temperature. Only the elements oxygen, nitrogen, hafnium, tin, and aluminum, raise the temperature of this transformation, increasing the useful temperature range of the alloys and of these only tin and Al contribute significantly to elevated-temperature strength. Oxygen and nitrogen increase the strength at room temperature but their influence is largely lost at 900 F.

Experimental alloys have been prepared for mechanical-property studies at several laboratories. The yield strength at 932 F of some of the experimental binary alloys are plotted in Fig. 3. The alloys containing

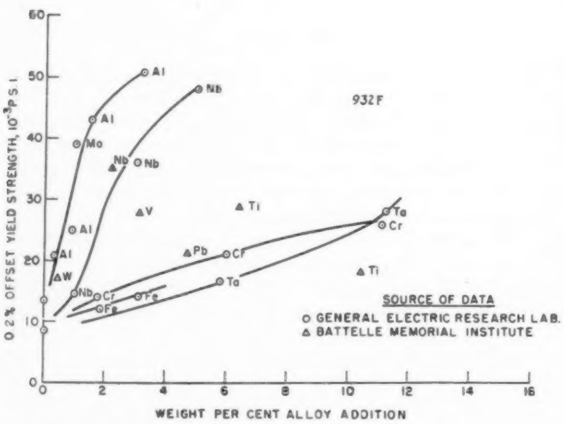


Fig. 3 Yield strength at 932 F versus alloy content for a number of zirconium-base alloys

aluminum, niobium (columbium), or molybdenum possess the greatest yield strengths at 932 F. Ternary alloys have been produced with yield strengths at 932 F greater than 50,000 psi, all of which contain aluminum. Three of these contain titanium and three contain molybdenum or tantalum. It should be remembered that yield

Table 4 Mechanical Properties of Zircaloy-2

	Room temperature	500 F
0.2% yield strength (A), psi	44,500	
Reduction in area (A), per cent	28.4	
0.2% YS (B), long, psi	49,400	24,400
0.2% YS (B), trans, psi	70,000	34,100
Reduction in area (B), long, per cent	28.3	42.2
Reduction in area (B), trans, per cent	37.1	52.4

	−310 F	32 F	212 F	392 F	572 F
Impact strength (ft-lb) (C)	4	6	7	17	91

Creep properties at 650 F: Stress, psi	Minimum creep rate, in/in/hr	Intercept strain, per cent
19000	1.95×10^{-6}	1.32
21000	5.86×10^{-6}	1.96
24600	2.96×10^{-5}	4.15
27200	6.1×10^{-4}	16.1

Endurance limit at 600 F 27500–28000 psi

(A) Annealed 20 hr at 1382 F and furnace-cooled.
(B) Annealed 10 min at 1550 F
(C) Heat-treated 1 hr at 1850 F, water-qrenched, and aged 3 hr at 600 F, followed by slow cooling.

strengths are obtained from short-time tests and do not necessarily reflect the long-time (creep-rupture) strength of the material. From the foregoing results, it is apparent that strengthening zirconium at temperatures up to 932 F is not too difficult. Combining high strength with good corrosion resistance and low neutron absorption is considerably more complex.

Zirconium alloys must be corrosion-resistant in contact with various coolants such as water or liquid metals. Where zirconium has to be used in contact with high-temperature water or steam, the alloying problem is primarily that of corrosion resistance, and mechanical strength is secondary. Studies have shown most elements, Si, Ti, V, Al, Cd, Ce, La, Mn, Nd, Pd, Zn, Ga, V, N, O, C, Ca, Me, and Cl, are harmful in regard to the resistance of zirconium to water corrosion. A few elements have been found beneficial, however.

Tin, iron, nickel, and chromium delay the initiation of accelerated corrosion in hot water but the latter three do not counteract the effects of nitrogen and carbon as does tin. Niobium, tantalum, and antimony also offset the effect of nitrogen but are not as effective as tin in doing so.

Zircaloy-2, a complex zirconium alloy containing tin, iron, nickel, and chromium is used because of its ability to delay the formation of flaky corrosion product. Zircaloy-2 combines good corrosion resistance, low neutron absorption, and improved mechanical strength. Its mechanical properties are listed in Table 4.

Few or no impact data are available for many of the zirconium alloys. Mudge has reported that zirconium 2.5 per cent tin alloys can remain ductile to very low temperatures, although hydrogen and its distribution can affect ductility adversely. Zircaloy-2 impact data are given in Table 4.

Acknowledgments

The experience of other AEC laboratories and subcontractors has been used in summarizing zirconium fabrication behavior. References on fabrication and alloy development are included in the original paper which will be published in the Transactions of the ASME.

Evaluation of Engineering Education

Résumé of ASEE report on changes required in curricula to meet today's engineering needs and to provide tomorrow's creative leaders

By L. E. Grinter[1]

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The ASEE Committee on Evaluation of Engineering Education was appointed by President S. C. Hollister in May, 1952, following discussion by ECPD of the need for a thorough restudy of the objectives of engineering education. The charge to the committee was to determine what changes are needed now in engineering education (1) for it to keep pace with the rapid advances that are occurring in science and (2) to provide the next generation with engineering leaders having the capacity to apply new scientific discoveries in a creative manner. The final report covers the committee's studies over a three-year period during which more than two-hundred educational reports from institutional committees on engineering education, from engineering societies, industrial organizations, and individuals were studied. This résumé is intended to give engineers a better insight into the problems of engineering education. It is hoped that many practicing engineers and all engineering educators will read the full text of the report.[2]

Objectives of Engineering Education

The objectives of engineering education are twofold and are related to the technical and social responsibilities of engineers. The technical goal is preparation for the performance of analysis and creative design, or of construction, production, or operation in which a full knowledge of the analysis and design of the structure, machine, or process is called for. The Committee on Evaluation has concluded that the greatest curricular deficiency in achieving the technical goal of engineering education lies in inadequate preparation of engineers in basic science including mathematics, in engineering science and in the planned use of this science background in engineering analysis, in the study of engineering systems, and in preparation for creative design.

The second objective, the broad social goal of engineering education, includes the development of leadership, the inculcation of a deep sense of professional ethics, and the general education of the individual. In this area there is less unanimity of educational opinion, but there is a clear consensus of industrial and other employers who consider the young engineer to be unnecessarily handicapped by inability to convey ideas to others in a clear, logical, and interesting manner using correct and concise oral or written language. There is wide agreement that technical competence alone is insufficient and that a reasonable fraction of the engineering curriculum must be directed toward achieving a liberal education for engineers.

The Faculty

Full recognition is given to the competency of the faculty as the most important factor influencing the quality of engineering education. The teaching of engineering as a liberal subject in a professional curriculum requires a teacher who inspires students toward intellectual honesty, professional integrity, and creative endeavor. Such a teacher will be intellectually creative in addition to possessing strong personal characteristics.

For a relatively young candidate for a faculty position, the strongest evidence usually available to measure probable creative ability in teaching and research is an educational background that includes the doctor's degree. For experienced persons evidence of capacity for creative teaching and research may be gaged more effectively by other criteria. Certainly, appropriate industrial or other engineering experience is essential to a well-balanced faculty. The minimum requirements for good teaching are complete mastery of subject matter far beyond that to be taught and the ability to draw students into active participation in the learning process.

In developing a strong faculty, care must be given to recruitment, evaluation, and training. For the young teacher, training should encompass both teaching and professional activity. Seminars and formal or informal conferences between experienced and inexperienced teachers can be used effectively for imparting a knowledge of teaching methods. Close association with engineering work or research in industry should stimulate the teacher and improve his teaching. Attendance at technical society meetings has a somewhat similar influence. Consulting is another important source of ideas for teaching and research. The belief is widely accepted that an average of one day per week of a teacher's time devoted to consulting activity of a high professional character will reflect to the over-all advantage of the institution.

[1] Chairman, Committee on Evaluation of Engineering Education, and Past-President of the American Society for Engineering Education.

[2] Report on Evaluation of Engineering Education, 1952–1955, published by the American Society for Engineering Education, June, 1955, Urbana, Ill. This investigation was sponsored financially by the American Society for Engineering Education, the Engineering Foundation, the Constituent Societies of the Engineers' Council for Professional Development, the General Electric Company, and the National Science Foundation.

Faculty Evaluation

Evaluation of a faculty is a necessary phase of good educational administration. Evaluation must be made as objective as possible and should include:

(*a*) The effectiveness of the individual's teaching based upon knowledge of subject matter, intellectual capacity, quality of judgment, professional and personal stature, and qualities of personal leadership as shown in his ability to inspire students.

(*b*) His productivity in research and other creative areas including new methods of presentation of subject matter in his undergraduate or graduate courses.

(*c*) His professional development as evidenced either by progress in early years toward advanced degrees, or later by his attainments and recognition as a scholar in his field.

(*d*) His significant publications.

(*e*) His activity in professional societies, government, and community affairs.

(*f*) The nature and responsibility of consulting services rendered to other areas of the university and to outside organizations. Based upon objective evaluation it is believed that an engineering faculty should include at least one teacher in five who has attained professional distinction. To retain such persons on a college faculty staff requires compensation competitive with industry since creative engineering work in industry or government is inherently attractive to the best engineering minds.

Instructional Goals

In order to teach most effectively, the teacher needs to adopt a set of personal instructional goals. For example, one goal should be to help the student to learn to deal with new situations with confidence and judgment based upon fundamental principles. As another goal, economic and social concepts as related to engineering decisions can be kept before students by an occasional example. The translation of new scientific developments into engineering practice will be facilitated by teachers who have as their goal to emphasize by generalizations the unity of concept among such subjects as heat flow, fluid flow, electromagnetic fields, and vibration theory.

Finally, every teacher should desire a liberal education for his students and should encourage understanding and appreciation of the humanities and the social sciences including the arts of communication by providing stimulating opportunities for discussion of these matters in relation to engineering problems. As a corollary, no engineering teacher can disparage the work of his colleagues in nonengineering fields without detracting from their effectiveness in teaching his own students.

Curricular Recommendations

The curriculum takes perhaps an undue share of the report, but suggested changes must always be discussed at length to avoid misunderstanding.

The great changes in physics and chemistry over the past thirty years and the equally great advances in engineering practice do not seem to have produced an equivalent counterpart in a reorganization of engineering curricula. A group of industrial advisers to the Committee has pointed out that the problems in production and manufacturing are now demanding greater and greater scientific background for engineers. As one example, emphasis was placed upon automation as a current problem of the machine designer. The need for such instruction is critical in certain industries, and several of these offer such courses to their personnel. If this is generally true, engineering education may be a decade late in giving emphasis to electronics in the curriculum of mechanical engineering. Greater adaptability to rapidly changing conditions seems clearly needed in engineering education.

But, fortunately, some things do not change. Whether we look a generation or a century ahead, reactions, stresses, and deflections will still occur, and they will have to be calculated. Electrical currents and fields will follow unchanging laws. Energy transformation, thermodynamics, and heat flow will be as important to the next generation of engineers as to the present one. Solids, fluids, and gases will continue to be handled, and their dynamics and chemical behavior will have to be understood. The special properties of materials as dependent upon their internal structure will be even more important to engineers a generation hence than they are today. These studies encompass the solid unshifting foundation of engineering science upon which the engineering curriculum can be built with assurance and conviction.

Based upon such considerations, the committee recommends less specialization in terms of extensive intradepartmental offerings and greater dependence upon basic science, engineering science, humanities, and social studies. Departmental sequences serve their primary purposes as opportunities to apply fundamental scientific knowledge to analysis, design, and the study of engineering systems. The committee agrees with the basic concept expressed by industrial leaders that specific details of engineering practice change too fast to be of value for classroom study except as they may serve the high purpose of illuminating fundamental unchanging principles. If this criterion is applied rather forcefully by engineering faculties, it is felt that opportunity will be found within the usual time limits to increase basic studies in science and humanities as recommended in the report.

In particular, the committee sees the need for increased study of mathematics, physics, and chemistry. It sees mathematics through ordinary differential equations, an introduction to nuclear physics, and more attention to physical chemistry as normal requirements of modern curricula in engineering. Great emphasis is given to the importance of the instruction in engineering science and its proficient application to analysis and design in engineering. An engineering science by definition involves largely the study of basic scientific principles as related to and as interrelated through engineering problems and situations. The fields of engineering science are defined specifically in the report to include mechanics of solids (statics, dynamics, and strength of materials); fluid mechanics; thermodynamics; electrical theory (electrical circuits, fields, and electronics); transfer and rate mechanisms (heat, mass, and momentum transfer); and the nature and properties of engineering materials. Of course, these six titles of the engineering sciences should be regarded as generic and broadly definitive rather than as representative of courses now being offered. It is recognized that other engineering sciences may be expected to develop and that, alternately, there may be

some curricula for which sciences other than those listed must be chosen, for example, an earth science or a life science.

It is recommended that about a quarter of the engineering curriculum be devoted to the study of the engineering sciences and about an equal fraction to their application in a departmental sequence in engineering analysis, design, and engineering systems. Hence the organization of basic science, engineering science, and engineering analysis and design becomes an integrated sequential study of great importance.

Humanistic and Social Studies

Among the many comments from employers of engineers that have been received by the committee none has come with greater frequency or stronger conviction than that urging the importance to engineers of the arts of communication and of social understanding. There is a nearly universal concensus among employers that engineers suffer unduly from lack of capacity for clear, concise, and interesting exposition and that they are limited in their ultimate development by an inadequate understanding of the humanities and the social studies. Although this viewpoint is accepted as true, there remains some question whether increase of fixed requirements of humanistic and social courses for all engineering students will eliminate this weakness.

A decade ago, an ASEE Committee recommended that about one fifth of the curriculum be in humanistic and social studies, but even this concession has not proved sufficient. Rather than to establish an increased percentage of the curriculum beyond this widely accepted figure of 20 per cent, the committee has concluded that a minimum of one course per semester for seven or eight semesters plus a broad opportunity for students to elect additional humanistic and social courses would be preferable. For students with cultural interests, all electives might appropriately be chosen in the nontechnical field to produce about the same background as that of a liberal-arts student who chooses to major outside of the humanities or social studies. The success of this approach will depend upon a genuine community of interest and more meaningful co-operation between teachers of engineering and those in the liberal arts. For true success in liberalizing engineering education, these two must respect and sustain each other.

The fields of the humanities and social sciences from which some courses must be selected include history, economics, and government wherein knowledge is essential to competence as a citizen; and literature, sociology, philosophy, psychology, and fine arts which afford means for broadening the engineer's intellectual outlook. In contrast, it is observed that many curricula list as humanistic or social courses such technical subjects as accounting, industrial psychology, investment economics, corporate organization, city management, or ROTC. The committee questions the value of such studies as a major contribution to liberal education and considers that they should be classified as nonengineering technical courses with appropriate additional time provided for humanistic and social studies.

An Experimental Curriculum With Scientific Orientation

Emphasis is placed upon the fact that experimentation rather than standardization is needed in curriculum development. However, in order to demonstrate that its ideas are practical, the committee has found it necessary to offer an experimental time distribution for the scientifically oriented curriculum that it recommends for consideration (Table 1).

It will be noted that the fractions given do not total exactly 100 per cent. Hence it should be evident that the committee does not desire this suggested distribution of emphasis to be restrictive. There will be many reasons for variations among institutions and among departments of a single institution. Experimentation, however, is strongly encouraged.

The committee's interest in this curriculum outline is centered in (1) the indication that the concept of a four-year scientifically oriented curriculum is practical in many fields of engineering, although it takes no position that four years or any other length of curriculum represents the supreme *desideratum*, (2) the fact that considerably more than the "common freshman year" might be arranged, if desired, as one result of scientific orientation of curricula, (3) that even with increased science background time may be provided for elective or option study to offer the student an opportunity to try his wings in one or two directions. Such elective study can contribute to a stronger humanistic-social background for some engineers and a stronger science background for others, with resultant over-all strengthening of the profession of engineering.

Table 1 Experimental Time Distribution for Scientifically Oriented Curricula

	Fraction of curriculum
Humanistic and social studies	about one fifth
Mathematics and basic science	about one quarter
Engineering science	about one quarter
Major departmental sequence of analysis, design, and engineering systems including necessary technological background	about one quarter
Choice of options or electives in (*a*) humanistic-social, (*b*) basic science, (*c*) engineering science, (*d*) research or thesis, (*e*) engineering analysis and design, (*f*) management	about one tenth

Graduate Study

The case for having a graduate program rests upon the influence it has in strengthening and vitalizing the pursuit of an institution's primary goals. It is traditional for institutions of higher learning to serve two ends, that is, education and research. Graduate study partakes of both, hence the need for graduate education varies with the rate of advance in the use of science characterizing fields of engineering and is greatest where science can contribute most directly.

Of course, mathematics is a most important study because the engineering-graduate student requires additional mathematics beyond ordinary differential equations to become technically literate and to convey scientific explanations to others. Fortunately the mathematics and science background found necessary for one engineering specialization will be almost exactly paralleled in many others, which explains the power of engineering analysis as a tool for leveling the constricting walls of professional specialization. At the master's level anything less than a full-year course in mathematics beyond elementary differential equations appears inadequate for effective understanding and use of scientific

principles on which advanced work in engineering almost inevitably will be based. Since graduate work in engineering must lean so heavily upon basic sciences, it is doubtful whether it should be undertaken by an institution unless its departments of mathematics, physics, and chemistry also are operating at the graduate and research level.

Requisites for Strong Graduate Work

The essential requirements of a strong graduate program are stated quite simply. They are (1) a qualified faculty, (2) qualified students, and (3) adequate administrative and financial support. To an even greater extent than in undergraduate education an outstanding faculty is the single most important requisite of a successful graduate school. In his teaching, the graduate faculty member usually deals with students as colleagues whether in the classroom, office, or laboratory. This obligation to the student cannot be fulfilled properly unless the graduate teacher is doing creative work on the frontiers of knowledge and presenting it to the profession.

A faculty having the requisite abilities for conducting a graduate program will insist that the graduate student body be intellectually and temperamentally qualified for graduate-level work for which high standards of selection and advancement are essential. In general, experience indicates rather marked correlation between a student's standing relative to his undergraduate classmates and his subsequent performance in graduate work. If his undergraduate record can be classed as upper quartile in an ECPD accredited institution, it may be assumed that he has the general qualification for completion of a master's program. The great majority of good doctoral risks will fall within a much smaller fraction, probably the upper tenth or less of the graduating class. The committee recognizes that exceptions to these general limitations do occur but it considers an attitude that most students deserve a chance at graduate study to be inimical with the intellectual objectives to be achieved and to be damaging in its effect upon those who are qualified for graduate study as well as those who are not.

Both statistically and in the minds of those concerned with engineering education, graduate study has become an element of such major importance that it must be considered as a natural development of almost every engineering college. Also, the committee concludes that except during a major economic recession, the supply of engineers who have successfully pursued graduate study will fail to meet the demand by a very significant margin. Nevertheless, since the cost of meeting the responsibilities of graduate education is two to ten times as great per student as for undergraduate study, institutions should not carelessly take the step of accepting graduate students.

Influence of Contract Research

Sponsored research programs contribute but cannot carry more than a small part of the extra costs of graduate education. Their greatest value is in providing a means of professional growth of staff members as well as real challenging problems on which graduate students may work. The committee would warn institutions, however, that excess growth of contract research can so consume the time and energies of the staff that their contributions to education may be restricted.

The Full Report

The complete report considers factors in engineering education from high-school preparation through graduate study. Further study of both extremes of this educational spectrum is needed since the greatest pressures and the most rapid changes are occurring there. The part of the report that applies to undergraduate curricula has determined the characteristics that distinguish an engineering curriculum from those in science and in subprofessional technology. The committee has attempted to consider the changes needed now in engineering education in order that it may serve the needs of the engineering profession a generation hence when present students will have become professional leaders. In determining desirable levels of mathematics, basic science, engineering science, and social or humanistic studies for engineering curricula, the committee has been concerned with reasonable, attainable objectives rather than with minimum standards of accreditation which is the province of ECPD. The Report on Evaluation of Engineering Education is offered, therefore, as indicative of the direction in which engineering education should and doubtless will evolve.

Recruiting the Best Engineering Minds for Graduate Study

It is clear that institutions are not stimulating a sufficiently large percentage of their top undergraduates to consider graduate study as a normal step in professional education. The committee believes that much could be done in this regard by planned presentation of the opportunities and rewards of graduate study to juniors before a final decision regarding employment is reached. The upper fraction of undergraduates should be told that the best advanced education for the differing functions of engineering is that which will develop the intellectual capacity of the individual rather than high specialization toward a given functional objective. They also should know that in graduate study the student takes the initiative to work on his own as a full-fledged partner without undue assistance and that the best graduate education is custom-tailored to the individual student. These concepts will challenge the sharpest minds. But, of course, unless stipends of fellowships and assistantships are brought in line with advancing engineering salaries and with the fact that more and more graduate students have dependents, many and perhaps most of the best minds inevitably will be channeled into immediate employment. Finally, industry must be made aware that it has a very great stake in increasing the number of graduate students even at the loss of immediate employees and at the cost of competitive graduate or research fellowships that only it can provide.

Water Problems in Power Generation at Supercritical Pressures . . .

. . . or Through the Looking-Glass

By Everett P. Partridge

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The chemical engineer who has to make water behave under any and all adverse conditions never lived in a more stimulating period than the present. On the one hand nuclear power, and on the other the large blank area we call the supercritical region challenge him with new problems—or, perhaps we should say, with old problems transposed into new co-ordinates.

Let us consider only what we may run into as real water—not the abstract substance mentioned in the steam tables but real, chemically active water—is used in a once-through boiler system at a pressure and temperature well above the critical point, for example 5000 psi and 1200 F.

Operating in Supercritical Range

In a boiler designed to operate in the supercritical range, we must still be concerned with deposits that impede heat transfer or lower turbine capacity. We must still guard against the insatiable thermodynamic urge of water to convert iron into iron oxide. But these old problems have a strange, unpredictable new appearance, as if the critical point were the Looking-Glass and we were companions of the justly famous Alice who stepped up through it into a land where everything was reversed.

The round trip through the Looking-Glass and back out again involves us in semantic as well as technical problems:

1 We start out with feedwater which we would all recognize as liquid water.

2 The feedwater is pumped into a circuit in which the pressure is 5000 psi, well above the critical pressure of about 3200 psi.

3 Without boiling, or other indication of any change in phase, the water under this pressure is pumped through a heat exchanger which raises its temperature to 1200 F, passing casually through the critical temperature of 705 F on the way.

4 The supercritical fluid—is it water or is it steam—then enters a turbine within which its pressure and temperature are progressively reduced. Without any change in phase, it becomes what we are accustomed to calling steam.

5 Toward the low-pressure end of the turbine, liquid water begins to appear as a second phase.

6 In the condenser we regain practically all of our original water in its original liquid state.

Presented at the Diamond Jubilee Mechanical Engineering Conference under the auspices of the Pittsburgh Section, Pittsburgh, Pa., April 4, 1955, of The American Society of Mechanical Engineers.

This could be summed up as the process of making steam which is not steam in a "boiler" which does no boiling.

Supercritical Fluid Is a Good Solvent

Much of our ability to condition water for steam generation today depends on a knowledge of how much of a substance will stay in solution in water under various conditions. As yet we have only glimpses of the solubility of familiar substances in the unfamiliar supercritical region. Such information as is available has been given to us by geophysicists exploring downward from their domain of high pressure and high temperature toward the critical point. Morey and Hesselgesser, in particular, have given us some numbers for the solubility of silica, sodium chloride, sodium sulphate, calcium sulphate, and iron oxide in supercritical fluid (1,2).[1]

Silica. Quartz will dissolve in pure highly compressed supercritical fluid at 5000 psi and 1110 F to the extent of 360 ppm (2). Fig. 1 contrasts strikingly the difference between this value and the fraction of 1 ppm of SiO_2 which could be transported in what we now call "high-pressure" saturated steam leaving a boiler at 2000 psi.

Sodium Chloride, Sodium Sulphate, Calcium Sulphate. Some data collected in Table 1 show a similar picture

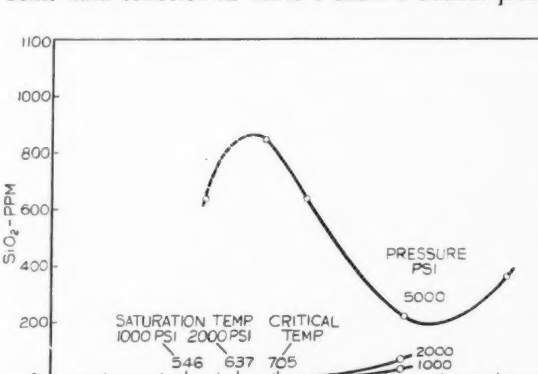

Fig. 1 Curve showing solubility of silica in steam

for sodium chloride and sodium sulphate (2). While the amount of either salt which can be carried in solution by saturated steam at 1000 or 2000 psi is not shown, it probably is very small. Superheated to 932 F, the steam

[1] Numbers in parentheses refer to Bibliography at end of paper.

Table 1 Solubilities of Sodium Chloride and of Sodium Sulphate in Steam and in Supercritical Fluid (1, 2)

Pressure, psi	—Temperature, deg F— 932	1121
	Sodium chloride, ppm	
1000	7	
2000	14	
4000	304	
5000		539
	Sodium sulphate, ppm	
1000	9	
2000	37	
10000	249	
15000	4307	

becomes capable of holding significant amounts of either the chloride or the sulphate. But when the pressure is increased above the critical point, the supercritical fluid shows itself to be a much better solvent than steam below the critical point. Morey and Hesselgesser even have noted that 16 ppm of calcium sulphate can be carried in solution at 15,000 psi and 932 F (2).

Possible Deposition in the Turbine

We could draw from these data the happy conclusion that salt deposits are not likely to form on the heat-transfer surfaces of a boiler generating supercritical fluid at 5000 psi and 1200 F from relatively pure water. Even though some soluble salts might leak into the condensate or the make-up, these would stay in solution while the water was being heated up under high pressure to become supercritical fluid. But what about the region in the turbine where we have to step back down through the Looking-Glass again and sodium chloride and sodium sulphate become virtually insoluble in the steam? Here we may have problems akin to the deposition of silica from steam in our contemporary central stations.

This silica problem has been met in current practice by keeping the silica in a 1400-psi circulating boiler down to as low as 1–2 ppm. Must we face the prospect of keeping not just silica alone but all dissolved solids continuously down to some such level or even lower in a once-through 5000-psi system? The solubility data, limited as they are, suggest that the answer is: "Yes."

Iron Oxide. So far we have been thinking only of the dissolved solids which might enter the cycle from the outside. Now let us take a look at the possible effects of the solvent action of supercritical water on the confining surfaces. From our experience to date we believe that the steel in a boiler operating at a high pressure of 1500 or 2500 psi is best protected from internal attack if the boiler water is definitely alkaline. Since the steel would keep on dissolving in the water if the iron oxide formed by the initial chemical action did not create a barrier, we explain the beneficial effect of alkalinity by saying that it causes the iron-oxide film on the steel to be tighter and less permeable than that resulting from contact with pure water.

The iron oxide is extremely insoluble at ordinary temperatures. We believe it becomes even less soluble as the temperature is increased toward the critical point and we are sure that it is less soluble in water containing a small amount of free caustic than in pure water. What happens, however, on the other side of the Looking-Glass? The single published fact is tantalizing in its implications. At a pressure of 15,000 psi and a temperature of 932 F, pure water passing over the mineral hematite, which is crystalline ferric oxide, picked up 90 ppm of Fe_2O_3 (2).

In the supercritical-pressure boiler, how much iron oxide, and perhaps also the oxides of chromium, nickel, and other alloy elements, will dissolve in the water under a pressure of 5000 psi as its temperature is increased to 1200 F? And what will happen to the metal oxides dissolved in this supercritical fluid as it passes into the domain of ordinary steam part way through the turbine?

Only speculative answers to these questions seem possible today. Iron oxide is universally found associated with amorphous silica in deposits from turbines, as if it had been transported by the steam. From the small amounts observed, we infer, however, that it dissolves only to a negligible extent in steam at contemporary high pressures, perhaps only to the extent of parts per billion. If we then supply to a turbine a supercritical fluid containing, let us say, 1 ppm of metal oxides, somewhere in that turbine the decrease in pressure and temperature will cause the steam to start to deposit the solid material it can no longer hold in solution.

Perhaps the metal oxides thrown out of solution will not stick on the surfaces of the turbine or of the tubes in the condenser. We might take hope from the observation by Morey and Hesselgesser (2) that they experienced no deposition in the exit line from their apparatus. However, this was true of their runs with silica, which does deposit in a turbine, as well as of the run with iron oxide.

If the metal oxides which seem likely to be present in the supercritical fluid do tend to accumulate in either the turbine or the condenser, what can we do about it? Perhaps the metallurgist can give us alloys, the oxide film of which will dissolve only at a very slow rate. Or perhaps we can develop a substance stable at the high temperatures involved which will form a protective barrier film between the metal surface and the hungry supercritical fluid.

Let us now consider what may happen if the metal oxides which separate from the supercritical fluid as it enters the domain of ordinary steam do not stick, but instead are carried along into the condensate. At first glance, one might become concerned about this material ending up as a deposit on the tubes in the boiler. But there is no boiling, and we would again be on the far side of the Looking-Glass, where the solubility of the metal oxides in the supercritical fluid might well tend to increase continuously with temperature. Instead of forming a deposit as the temperature increased, the metal oxides would go back into solution. The system as a whole would then tend to approach a steady state, with metal oxide recirculating continuously, in solution from the boiler to the turbine and as dispersed particles, possibly of colloidal dimensions, from the turbine back into the boiler.

Possible Transformation of Iron Oxides. Another unknown factor of possible significance is the transformation of Fe_3O_4 into Fe_2O_3 and vice versa. The temperature at which these oxides are in equilibrium in air is calculated to be 1060 F. Such equilibrium measurements do not always suffice to predict which actual form of a substance will crystallize from solution at a given temperature. However, we might find Fe_2O_3 dissolving from the surfaces toward the hot end of the boiler circuit, but crystals of Fe_3O_4 depositing in the middle stages of the turbine. A corollary of such an exchange

would be a net release of oxygen which presumably would react promptly either with metal or with the hydrogen which will inevitably be a component of the system. The over-all reactions might be represented most simply by

$$3\ Fe_2O_3 \longrightarrow 2\ Fe_3O_4 + O$$

$$4\ O + 3\ Fe \longrightarrow Fe_3O_4$$

$$O + H_2 \longrightarrow H_2O$$

Some Old Problems Disappear

In boilers where boiling actually takes place, we currently run into difficulties here and there with the products of the boiling process. Passing through the Looking-Glass into the land where "steam" is produced without any formation of bubbles of vapor from liquid water on a hot metal surface should free us from these particular problems.

Steam Blanketing. In the supercritical heat exchanger, even a horizontal tube will not develop an insulating blanket of steam along its ceiling. Throughout the entire boiler one homogeneous phase will flow smoothly on its way to the turbine. No longer shall we be able to argue whether or not the failure of a vertical wall tube could have been caused by local blanketing due to film boiling.

Attack by the Concentrating Film. In any true boiler there is an inevitable tendency to accumulate dissolved solids where steel and water and steam are momentarily in contact during the formation of a bubble of vapor. The concentrating film developed where boiler water is fried out on a strongly heated tube has caused serious internal attack in many boilers (3). But once we eliminate the formation of vapor, we can have no concentrating film. Any attack will be more general, except as localized stress may tend to concentrate it.

Practical Experience

The few data we can bring to bear on the subject imply that water might cause less trouble for the supercritical pressure boiler than for the turbine it serves. Is there any practical experience which will give us some measure of the size and shape of potential problems?

Supercritical Experimental Boilers. While it would not be surprising to learn from a Soviet news release that boilers were operated at supercritical pressures in Russia in 1873, the earliest published records known to us are those of Kerr (4) and of Potter, Solberg, and Hawkins (5) in 1932. Kerr described an experimental once-through boiler which was operated at pressures from 1500 to 5000 psi and a maximum temperature of 800 F. This unit comprised 7 circuits of 1-in. tubes. The feedwater was condensate-treated with a slight amount of phosphate and caustic soda to maintain a pH of 10.5. No corrosion or scale formation was experienced, the chemicals passing through to the condenser without any apparent adverse effect.

In their companion paper, Potter, Solberg, and Hawkins (5) reported excursions just on the other side of the Looking-Glass in an experimental unit operated at 1500–3500 psi and a maximum temperature of 830 F. Trisodium phosphate was used to condition the boiler water, with the control limits shown in Table 2. No difficulty with deposits or corrosion was mentioned.

Table 2 Chemical Conditioning Limits for Experimental Boiler of Potter, Solberg, and Hawkins (5)

Total solids	<1500
Total alkalinity, ppm Na_2CO_3	<75
Sodium phosphate, ppm Na_2HPO_4	<40
pH	10.0–10.5
Dissolved oxygen, ml/l O_2	0.0–0.1

The Benson Boiler. In neither of these cases was supercritical fluid from the boilers passed through a turbine. In fact, this may not yet have been done, although the early Benson boilers were designed to operate at the critical pressure. The first one, built in 1923 by the English Electric Company at Rugby, England, had a capacity of 10,000 lb/hr. When Siemens-Schuckertwerke acquired the rights to Benson's development, this boiler was moved to Siemensstadt. One or two additional units were used at the Siemens-Gartenfeld cable works before the first large Benson boiler was built for the central station of Langerbrugge. The capacity of this unit has been reported variously as 100 metric tons/hr and 275,000 lb/hr. While the pressure at the drum was 3190 psig, at the turbine inlet it was 2840, significantly below the critical point. Steam temperature was 840 F.

Another Benson boiler originally designed to operate at the critical pressure went into service on the S.S. *Uckermark* in 1930. Mellanby, in commenting on this boiler, has said (6): "In the design special care is taken so to proportion the heating surface that those tubes containing only saturated steam are outside the radiation heat section, so that the majority of any deposit that may be made on the inner-tube surface will be away from the hottest gases, thus reducing danger of overheating."

Subsequent installations seem to have been built for lower pressures. When Cerna (7) reported on his survey of German power plants after World War II, he stated that the Benson boiler was the most common forced-circulation type in Germany, but that no critical-pressure units were in use. The highest pressure was 2200 psi, with 1200 to 1800 psi as the general range for high-pressure plants.

Some interesting experiences with a Benson boiler placed in service in 1951 have recently been reported (8). The design pressure was 2590 psig with a steam temperature of 1130 F. Make-up water was double-distilled to provide a salt content of 0.15 ppm in the primary circuit. Only volatile substances were used for internal chemical conditioning, 0.5 ppm of hydrazine and 0.2 ppm of ammonia being added.

After Benson and the engineers of Siemens-Schuckertwerke had stepped up to the Looking-Glass, why did they retreat? Perhaps the reasons were, in the main, mechanical or metallurgical in nature. Through a dense haze of speculation, we can only guess that there were also some problems in making water behave. Only those who are in the thick of the current development work now being conducted by various boiler manufacturers are in a position to speak with much authority and they probably would like to wait awhile.

A Plea for Co-Operative Research

The words "perhaps" and "possibly" and "speculative" have appeared frequently in this discussion because we have a ratio of fact to opinion approximating

(*Continued on page 903*)

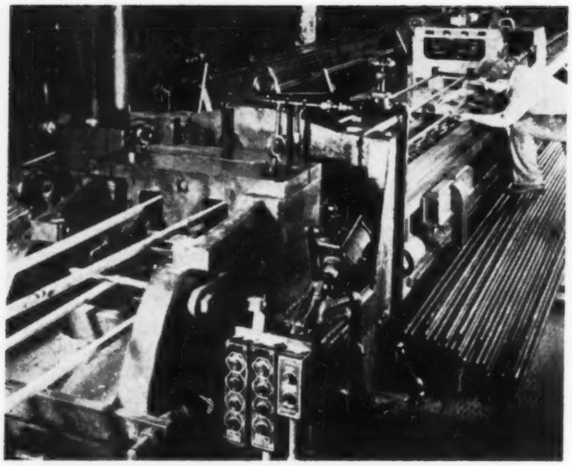

Fig. 1 Draw bench employed for cold-drawing operation

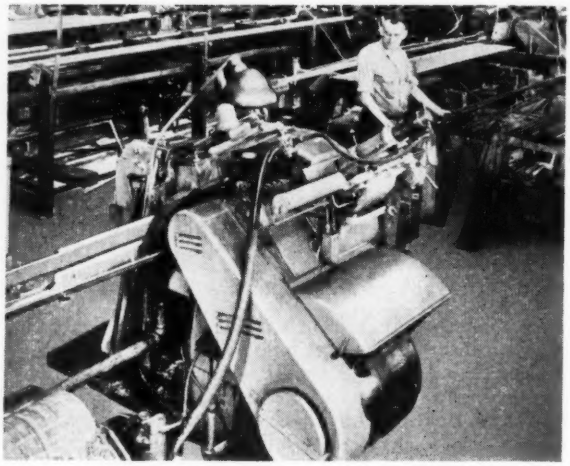

Fig. 2 Grinding round steel bars on centerless grinder

Residual Stresses in Cold-Finished Steel Bars . . .

. . . and their effects on manufactured parts

By Elliot S. Nachtman

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La Salle Steel Company, Hammond, Ind. Associate Member ASME

THE PRODUCTION of cold-finished steel bars is an important specialty of the steel industry. This production technique is intermediate between the making of steel and hot-rolled material on one hand, and the manufacturing of parts on the other. Hot mills produce hot-rolled material in coils or cut lengths which serve as the raw material for the cold-finishing operation. This bar stock varies widely in composition, from plain carbon steels to steels containing various concentrations of one or more alloying elements, such as nickel, chromium, vanadium, and so on.

Hot-rolled bars are cold-finished in order to secure a number of possible improvements, as follows: (*a*) Superior surface finish; (*b*) better machinability; (*c*) improved wear resistance; (*d*) closer dimensional tolerances; (*e*) higher strength.

Cold finishing is the general term used to describe various combinations of processes used to finish hot-rolled stock. The particular sequence of operation used depends upon requirements for subsequent fabrication. By appropriate selection of chemistry and cold-finished sequence, many different combinations of surface finish, dimensional tolerance, physical and mechanical properties as well as carburizing, heat-treating, and welding capabilities may be made available in the cold-finished bar.

Cold finishing may be classified into six different basic operations: (*a*) cold drawing, Fig. 1; (*b*) turning; (*c*) grinding, Fig. 2; (*d*) polishing; (*e*) thermal treatments; (*f*) straightening; Fig. 3.

Representative mechanical properties which are achieved by a combination of cold-drawing and subsequent strain-relieving are illustrated in Fig. 4 (1).[1] Because of the versatility in producing properties and characteristics to fit all manner of specifications, cold-finished bars are basic starting materials for innumerable fabricated products.

According to information published during the past few years, many fabrication problems as well as the very life of the finished part may be influenced profoundly by residual stresses. Some of these effects are well known but much remains to be explained. In this paper, the residual-stress patterns which normally are produced by the several cold-finishing steps, their effects, and practical implications will be described.

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[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

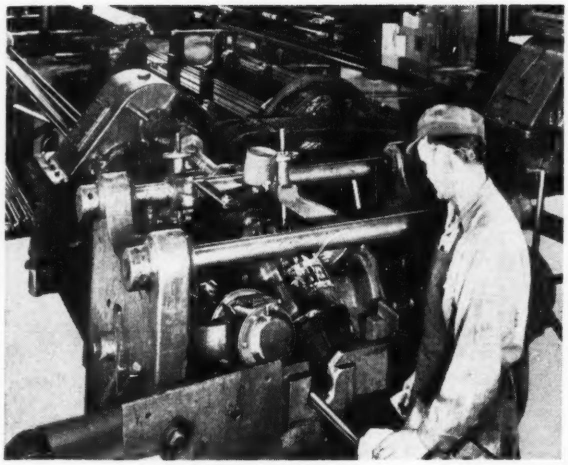

Fig. 3 Straightening bars following cold-drawing operation

affected profoundly by straining the material beyond the yield point.

Residual stresses have been classified into two types—macro (body) stresses (2), and microstresses (tesselated stresses) (3).

Residual macrostresses are those which result from nonhomogeneous deformation (e.g., cold-drawing) and they extend over large portions of the body. Residual microstresses are a result of nonuniform deformation in localized areas of the material such as individual grains.

Methods developed for determining residual stresses in cold-finished steel bars measure essentially macrostress. The most common methods are (*a*) the boring-out technique and its modifications (4, 5) and (*b*) deflection methods (6, 7).

In general, cold-finished bars contain residual stresses which vary longitudinally, circumferentially, and radially. Hence, whenever information about the stresses in all three principal directions is desired, the first technique is used. This method depends upon precise measurement of the dimensional changes as a solid bar or tube is carefully bored out from the center in a succession of small steps.

In the deflection technique, we measure the variable deflection of an originally straight bar as successive layers are removed from one of its surfaces. This method is useful where residual stresses are to be measured in one direction only.

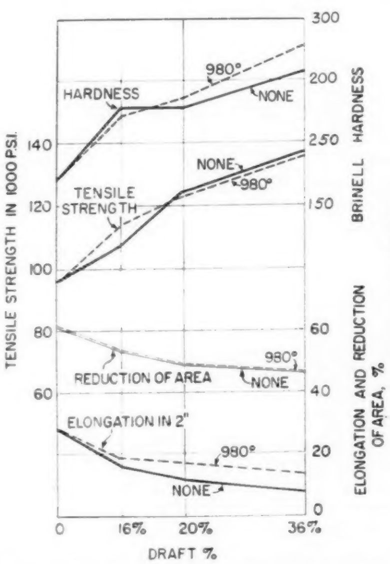

Fig. 4 Effect of cold drawing and stress relief on mechanical properties of $^{1}/_{2}$-in-diam, hot-rolled, resulphurized, 0.37 per cent carbon-steel rounds (1)

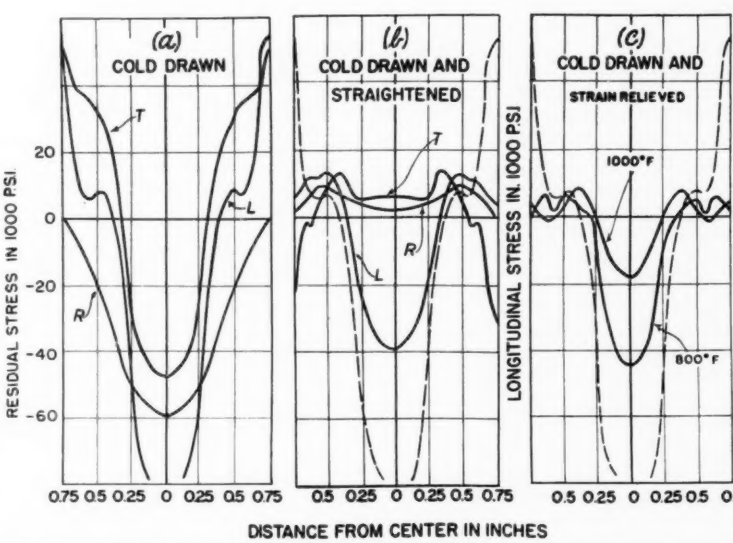

Fig. 5 Typical residual-stress distribution in a cold-drawn round, 0.45 per cent carbon steel, $1^{1}/_{2}$ in. diam, reduced 20 per cent L-longitudinal, T-tangential, R-radial stress (*a*) cold-drawn, (*b*) cold-drawn and straightened, (*c*) cold-drawn and strain-relieved

This information, when coupled with data gathered on the effects of subsequent manufacturing processes will aid in solving problems associated with residual stresses in manufactured parts.

Introduction to Residual Stresses

Residual stresses may be defined as those stresses which exist in a material not subjected to any external force. Residual stresses are associated with some type of inhomogeneity within a material. Such inhomogeneity may be brought about by cold deformation, heat-treatment, precipitation, or some other cause. Thus any operation which results in nonuniform displacement within the material produces a resulting stress pattern. Residual stresses are elastic stresses and can be

Straightening and Strain-Relieving

Cold drawing, Fig. 1, is accomplished by pulling the pickled and lubricated hot-rolled material through a die with a hole whose smallest diameter is less than the original diameter of the hot-rolled bar. Such a deformation process results in a residual-stress distribution of the

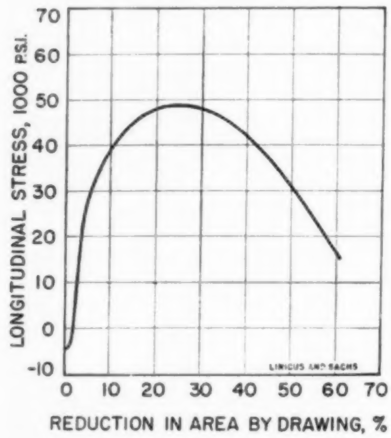

Fig. 6 Effect of increasing reduction on residual stress at surface of drawn wire; single drafts (8). Very small drafts may result in compressive stresses on the surface rather than the usual tensile stresses.

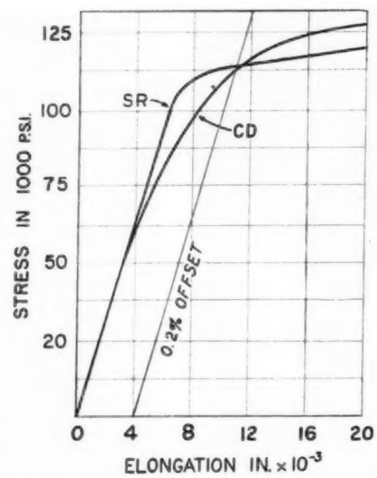

Fig. 7 Effect of stress relief at 900 F on yield strength of a cold-drawn, 0.45 per cent carbon steel; CD, as drawn, SR, as strain-relieved

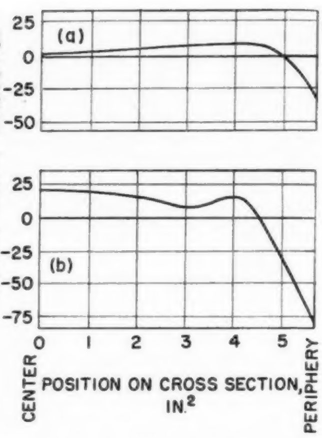

Fig. 8 Longitudinal residual stresses in burnished, 0.19 C steel bar, 2$^3/_4$ in. diam—(*a*) single pass, 0.0004 in. reduction of diameter; (*b*) two successive passes, 0.0010 in. reduction (15)

type shown in Fig. 5(*a*) with tension at the surface and compression near the center of the bar.

The level and magnitude of residual stresses depend upon the reduction of the bar cross section. Fig. 6 illustrates this variation in intensity of stress as the per cent reduction increases (8). Very small drafts may result in compressive stresses on the surface rather than the usual tensile stresses. The intensity of tensile stresses increases to some critical per cent reduction and then levels off, and with higher reduction decreases.

After drawing, round bars generally are straightened between two revolving skewed rolls, Fig. 3, one of which is ground with a concave face and the other with a straight face. The bars are fed through, and as they proceed, they are bent in all planes. This bending straightens the bar and also affects the residual-stress distribution in a manner depicted in Fig. 5(*b*).

The straightening operation effectively acts as a strain-relieving treatment with a resultant decrease in the level of stresses in the bar. It is of interest also to note that the major effect is at the surface as could be expected since the greatest plastic strain is introduced there.

Press straightening is used also in straightening large cold-finished bars. The local bending which produces a straight bar also introduces randomly modified residual stresses. Occasionally, straightening also may be carried out by stretching (5, 7, 9).

Strain-relieving at temperatures below the lower critical temperature is employed frequently to achieve desired physical properties, relieve stresses, and modify the yield: tensile-strength ratio. Fig. 5(*c*) illustrates the effectiveness of strain-relieving at two different temperatures with respect to lowering of residual-stress intensity. The higher temperature results, naturally, in a lower level of the locked-up stresses.

Equally important and interesting are the changes in the shape of the stress-strain curve brought about by thermal treatment. The as-strain-relieved curve SR (Fig. 7) shows an increased elastic range as compared with the as-drawn condition CD. The ratio of yield strength to tensile strength is raised at the same time.

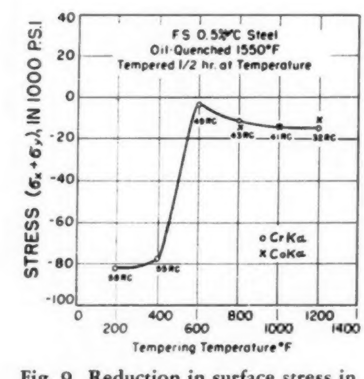

Fig. 9 Reduction in surface stress in heat-treated, 0.50-carbon steel (17)

By purposely varying the temperature and duration of the subcritical thermal treatment, it is possible to modify the tensile-yield ratio, and improve elastic properties, while at the same time substantially retaining the original tensile strength.

Turning, Grinding, Polishing

The machining operation may introduce residual stresses of various characteristics depending upon machining conditions (bar and tool material, lubricant, speed, feed, tool angles). Henriksen (10) found that tensile stresses are produced on the surface of turned carbon-steel bars even when light cuts are taken.

However, a Russian paper (11), reporting on the effects of high cutting speeds on both low-alloy and medium-carbon steels, reveals that there is a reversal of stresses on the surface at some intermediate cutting speed.

Hot-rolled bars, ground on centerless-grinding machines, will have a residual-stress distribution which, as in turning, is profoundly influenced by the grinding conditions as well as bar chemistry (12, 13). Available information indicates that tensile stresses are produced

in a superficial layer whose depth may vary from 0.001 to 0.003 in.

Polishing of bar stock may be accomplished using two roll machines similar to those used for straightening. As the bar passes through the revolving two rolls, the surface is burnished and consequently plastically deformed. Thus the effect on the surface residual stresses should be pronounced (14). In Fig. 8 a stress distribution typical of such a polishing operation is illustrated. Of interest is the fact that surface tensile stresses may now be made compressive.

Heat-Treated Steel

Cold-finished bars are frequently heat-treated either before or after the cold-finishing process. Such treatment, of course, produces residual stresses. If heat-treated bars subsequently are cold-finished, the stresses arising from heat-treatment are modified by the cold-finishing sequence. It would be of interest, however, to know the type of residual-stress pattern which is associated with heat-treatment followed by tempering before cold-finishing.

The residual stresses associated with heat-treating are influenced by the composition of the steel, the austenizing temperature, and the quenching procedure (15, 16, 17).

Fig. 9 gives an idea of the effect on stress intensity of tempering a plain 0.50 carbon heat-treated steel and clearly indicates that residual stresses of varying magnitudes may be produced on the surface of a bar after heat-treatment. Subsequent tempering treatments may then produce surface stresses varying from 3000 to 16,000 psi.

Manufactured Parts

Parts fabricated from cold-finished bar stock are processed in many ways. Such processes as machining, heading, heat-treatment, carburizing, straightening, plating, and so on, generally will modify the original residual-stress distribution and the effects of subsequent processing are important in explaining phenomena attributable to such stresses. This relationship is complex as has been illustrated previously. Some of the characteristics influenced will be discussed briefly.

Strength Properties. Such properties as the ultimate strength or ductility of a part are not altered significantly by residual stresses. The yield strength, however, is modified to a considerable degree as illustrated in Fig. 7. The change in yield strength described here is brought about by strain-relieving. The proportional limit is similarly affected.

Fatigue. Although considerable work has been done on the nature of fatigue in fabricated parts, this phenomenon is still not well understood. However, it is generally believed that compressive stresses which increase the apparent strength of the surface undergoing fatigue will benefit the life of the part (18, 19, 20).

Cracking. High levels of residual stresses associated with stress raisers (notches, segregation, and the like) may cause cracking. Thus the residual stresses should be kept low and the stress raisers removed by appropriate design or material specification.

Machinability. A high percentage of all cold-finished bars are machined during the fabrication of finished parts. The residual stresses in material being machined, if not controlled, may cause poor tool life because of seizure. The part may "close" on the tool, accelerating tool wear. In extreme cases, such seizure may result in tool breakage, for instance during drilling.

Tolerances. Similarly, excessive residual stresses may upset dimensional tolerances by causing the material to expand or contract unduly in certain directions during machining or other processing.

Corrosion. Surface residual stresses, particularly tensile stresses, accelerate attack by corrosive atmospheres. Residual stresses, therefore, on the surface should be kept as low as possible.

Acknowledgment

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A Study of College Graduates in the 1954 Edition of "Who's Who in Engineering"

By Charles J. Baer

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This is the fourth study of the college backgrounds of engineers listed in "Who's Who in Engineering." The previous three studies were made by Dr. Donald B. Prentice, Director of the Scientific Research Society of America, and covered the 1931, 1937, and 1948 editions of the same publication. Table 1 is presented which gives a tabulation of the 17,518 biographies included in the 1954 volume of "Who's Who in Engineering," and the other three tabulations are those of Dr. Prentice. The data in all four columns of Table 1 were compiled according to the same plan and therefore the figures are comparable. The table is self-explanatory, but a restatement of the plan on which the statistics were assembled will be given.

In compiling the data for this study, graduates of colleges in the United States and Canada, only, were considered and bachelor degrees controlled the assignments of individuals to institutions. Graduates of arts colleges who later received bachelor's degrees in engineering were credited to the engineering colleges. However, graduates of arts colleges who later received master's or doctor's degrees in chemistry, geology, or engineering, for instance, were assigned to the institutions at which first degrees were given. Graduates of engineering schools who later received advanced engineering degrees were credited to the colleges at which they carried on their undergraduate studies.

An engineer was not assigned to a college unless his biography clearly recorded graduation, either by statement of the degree received or the class in which the individual was graduated. For example, "ME, Cornell," "BS, Yale," or "graduate, Purdue 1920," would entitle a man to listing, but "engineering, Purdue," or "studied engineering at Illinois," or similar inconclusive evidence of receiving a degree was unacceptable. There is evidence to lead one to believe that many graduates failed to indicate clearly that they received degrees.

Several facts stand out when a comparison is made of the 1954 figures and the older studies:

1 From the 17,518 biographies, 16,142 clearly indicated bachelor's degrees in engineering or science. This percentage of 92 compares with 81 for 1948, and 76 and 82, respectively, for the 1931 and 1937 volumes of "Who's Who in Engineering."

2 A much larger list of colleges is represented in the 1954 edition than in 1948. The 475 institutions to which graduates were assigned in the 1954 "Who's Who" represent a 31 per cent higher figure than the 362 mentioned in the 1948 study.

3 There has been considerable shifting of positions of schools in the list from 1948 to 1954. For example, Michigan, Cornell, Purdue, and Illinois, in the number 2, 3, 4, and 5 positions, have all shifted, although these movements were not as spectacular as others in the list. State-supported schools continued to rise in the rankings, at the expense of some well-known private, or endowed, institutions. However, the Massachusetts Institute of Technology easily remained at the top of the list, as it was in the three previous studies.

4 It appears that schools whose faculties or alumni secretaries keep good records of their graduates benefit from these listings. In the case of the last two editions of "Who's Who in Engineering," at least, the publisher wrote to the dean of each college of engineering, asking for recommendations of graduates to be considered for inclusion in the publication. Those institutions having extensive records of alumni were thus able to supply the publisher with many names.

Table 2 is a percentage rating of 71 institutions which were able to supply the total number of BS or first degrees granted in engineering. Dr. Prentice previously had used total living alumni for comparing 17 institutes of technology or mining. Since only one of the first 20 colleges in the 1954 listing was able to estimate the number of living alumni, it was decided to ask each engineering school for the total number of engineering degrees granted through June, 1954, or through 1954.

Rating of institutions percentagewise, thusly, tends not to favor the older schools, which, of course, must have many deceased alumni. However, a large per cent of older and larger colleges rank above the mean, although the oldest school of engineering, Rensselaer, does not. It might be appropriate to state that many individuals whose biographies appear in the 1954 "Who's Who" are now dead. At least 2 per cent of those engineers assigned to one of the institutions in the first ten are deceased. The majority of graduates listed received their degrees between 1910 and 1940.

As a matter of interest, a third table was prepared for institutions not in the U. S. A. or Canada which had seven or more graduates listed. Since the degrees, or in some cases "diploma engineer" as they are often called, are not necessarily equivalent to the bachelor degree in this country, it would not be appropriate to rank these universities with those of this country without more extensive study. Many of the graduates listed are now practicing in the United States. It is interesting to note that the 14 institutions listed had more alumni listed than did the other 96 institutions which had less than seven individuals assigned.

Acknowledgment

Grateful acknowledgment is made to Prof. Frank L. Brown, and Mesdames Nora T. Cleland, Betty Mashburn, Mary McIntyre, and Mary T. Baer, of the University of Kansas, for help in making this study possible.

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Table 1 College Alumni Listed in "Who's Who in Engineering"

	College	1954	1948	1937	1931
1	Mass. Institute of Technology	930	933	761	664
2	Michigan	620	585	460	385
3	Cornell	582	677	611	562
4	Purdue	568	384	309	254
5	Illinois	496	450	364	295
6	Wisconsin	350	357	305	269
7	California	334	299	229	207
8	Ohio State	321	299	254	192
9	Kansas	301	219	124	119
10	Minnesota	298	269	182	157
11	Missouri School of Mines	283	95	44	55
12	Columbia	268	281	292	281
13	Iowa State	255	211	171	144
	Yale	255	270	270	256
15	Penn State	222	181	147	110
	Rensselaer	222	194	125	120
17	Stanford	210	188	132	145
18	Washington	208	155	107	82
19	Pennsylvania	207	213	197	179
20	Harvard	202	234	200	190
21	Texas	191	113	62	42
22	Kansas State	186	81	55	60
	Nebraska	186	132	111	93
24	Colorado	178	160	92	80
25	Lehigh	172	174	175	201
26	Texas A & M	164	93	41	34
27	South Dakota Mines	153	17	15	11
28	Case	152	135	105	85
29	California Inst. of Technology	146	107	34	19
30	Illinois Inst. of Technology	144	111	95	90
31	Worcester	141	155	147	145
32	New York University	136	123	39	36
33	Carnegie	133	101	51	35
34	Johns Hopkins	125	91	53	38
35	Cincinnati	122	100	64	41
36	Brooklyn Polytechnic	121	74	45	38
37	Washington Univ. (St. Louis)	119	103	73	67
38	Missouri	117	105	92	82
39	Virginia Polytechnic	114	58	37	37
40	Stevens	111	150	122	122
41	Princeton	110	102	68	68
42	Iowa	104	93	56	43
43	Cooper Union	102	65	51	41
44	Georgia Tech	100	86	51	33
45	College of City of New York	94	52	37	28
46	Michigan State	90	93	68	66
	Oregon State	90	55	30	20
	Tufts	90	105	54	39
49	South Dakota State	87	24	16	13
50	Kentucky	86	69	55	48
51	Maine	85	96	79	71
	U. S. Naval Academy	85	120	64	56
53	Rutgers	84	57	43	40
54	Colorado School of Mines	80	119	76	82
	Toronto	80	67	36	28
	West Virginia	80	46	33	33
57	U. S. Military Academy	79	89	78	92
58	Lafayette	78	57	49	40
59	Oklahoma	76	47	27	27
60	Brown	75	62	61	48
61	Chicago	73	66	52	35
	Drexel	73	43	8	4
63	North Carolina State	72	55	22	18
	Syracuse	72	80	64	56
	Utah	72	58	40	30
66	Rose	71	68	69	71
	Union	71	73	52	43
68	Pittsburgh	70	56	44	37
69	Northeastern	67	41	8	3
70	Washington State	66	...	...	...
71	Virginia Military Institute	65	24	25	23
72	Michigan School of Mines	61	87	100	96
73	Dartmouth	58	73	67	60
74	Rochester	57	22	16	15
75	Alabama Polytechnic	55	44	32	28
76	Tennessee	53	34	21	17
77	Virginia	51	49	41	24
78	Idaho	49	29	19	12
	North Carolina	49	51	25	23
80	Louisiana State	46	26	9	10
81	McGill	45	39	27	35
82	George Washington	44	...	...	...
	Pratt	44	16	...	...
84	Florida	42	28	9	10
	Rice	42	23	8	3
86	Alabama	41	32	15	5
	Vermont	41	43	33	28
88	Clemson	40	21	26	12
89	Detroit	39	20	13	4
	Northwestern	39	37	24	15
91	Arkansas	36	29	25	24
	Bucknell	36	32	24	13
	Tulane	36	47	42	34
94	Montana State	35	30	10	8
	North Dakota State	35	13	8	3
96	Ohio Northern	34	34	9	31
97	Maryland	33	12	...	...
	Newark	33	18	...	...
99	Colorado A & M	32	...	...	...
	Mississippi State	32	27	18	16
	North Dakota	32	30	19	15
	Queens	32	22	11	17
103	New Hampshire	31	25	22	13
104	Texas Tech. Institute	30	...	...	...
105	Notre Dame	28	22	14	12
	Swarthmore	28	31	27	22
107	Arizona	27	22	11	9
	Southern California	27	18	9	7
	Tri-State	27	20	...	...
110	Utah State	26	12	...	...
111	Clarkson	24	18	12	14
	Indiana	24	26	29	14
	Louisville	24	7	...	...
	Marquette	24	15	14	12
	Rhode Island State	24	20	13	12
116	Delaware	23	11	12	5
	Denver	23	18	...	...
	Oklahoma A & M	23	23	19	12
119	Vanderbilt	22	23	15	17
120	South Carolina	21	11	9	6
	Trinity (Conn.)	21	13	12	8
122	Catholic University	20	11	...	...
	Nevada	20	19	10	13
124	Alfred (New York State)	19	...	...	...
	Denison	19	20	16	15
126	Oberlin	18	12	7	8
127	New Mexico	17	7	...	...
	Valparaiso	17	21	14	15
	Washington and Lee	17	17	13	16
130	British Columbia	16	16	...	...
	Ohio University (Athens)	16	9	9	6
132	Citadel	15	8	...	...
	Colorado College	15	19	19	14
	Milwaukee	15	...	...	...
	Toledo	15	...	...	...
136	Montana Mines	14	20	...	...
	Santa Clara	14	...	...	...
	Wesleyan	14	16	9	6
	Wyoming	14	11	...	...

	College	1954	1948	1937	1931
140	Cornell College (Iowa)	13	13	11	16
141	Duke	12	...	...	...
	Manitoba	12	9	...	...
	South Dakota	12	10	...	...
	Williams College	12	13	12	11
145	Dayton	11	7	...	...
	Haverford	11	12	12	8
	UCLA	11	...	...	...
	Wayne	11	...	...	...
149	Allegheny	10	...	...	...
	DePauw	10	8	...	...
	Fenn	10	...	...	...
	Miami	10	8	...	...
	New Mexico State	10	...	...	...
	Norwich	10	11	17	19
	Ohio Wesleyan	10	11	10	7
	Saskatchewan	10	...	...	...
	Wooster	10	7	7	4
158	Akron	9	7	...	...
	Alberta	9	...	...	...
	Amherst	9	10	10	14
	Clark	9	8	...	...
	Franklin and Marshall	9	9	8	3
	Oregon	9	12	12	7
	Ripon	9	9	...	...
165	Colgate	8	12	10	9
	Georgia	8	9	8	11
	Grinnell	8	7	8	7
	Manhattan College	8	...	...	...
	New Mexico Mines	8	11	...	...
	Southern Methodist	8	...	...	...
	Webb	8	9	7	...
172	Boston University	7	...	...	...
	Colorado State	7	27	22	19
	Highland Park	7	8	11	9
	Temple	7	...	...	...
	University of the South	7	...	...	...
	Western Reserve	7	...	...	...
	298 institutions with six or less alumni listed	589			

Total number names listed, 475 U. S. A. and Canadian institutions	15589
Persons with degrees from 110 foreign schools	390
Persons with Bachelor degrees, or better, not assignable to any one college	163
Persons not having degrees	1376
Total biographies, 1954 edition	17518

Table 2 Proportion of Engineering School Alumni Listed in "Who's Who in Engineering"

	College	Total BS through June, '54	No. in Who's Who	Per cent listed
1	Dartmouth	877	58	6.62
2	Nebraska	3282	186	5.66
3	Rochester	1017	57	5.61
4	Kansas	5432	301	5.54
5	Missouri	2157[b]	117	5.42
6	Calif. Inst. of Technology	2706	146	5.38
7	Swarthmore	529[d]	28	5.29
8	Pennsylvania	4506	207	4.60
9	So. Dakota State	1897	87	4.58
10	Missouri Mines	6301	283	4.49
11	Virginia	1156	51	4.42
12	Stanford	4937 est	210	4.26
13	Cornell	15021	582	3.88
14	Yale	6800 approx	255	3.75
15	Iowa	2807[b]	104	3.71
16	Michigan	17265 approx	620	3.59
17	Utah State	744	26	3.50
18	Mass. Inst. of Technology	27088	930	3.44
19	Minnesota	8945[b]	298	3.35
20	Illinois	15024[b]	496	3.30
21	Columbia	8446	268	3.18
22	Washington Univ. (St. Louis)	3770	119	3.15
23	Kansas State	6072	186	3.07
24	Vermont	1374[a]	41	2.98
25	Washington	7324[b]	208	2.84
26	Texas	6776[b]	191	2.82
27	Ohio State	11398[b]	321	2.82
28	Tufts	3211	90	2.80
29	Rice	1579	42	2.66
30	Rose	2782	71	2.55
31	North Dakota State	1413	35	2.48
32	Alfred	774	19	2.46
33	North Dakota	1319	32	2.43
34	Kentucky	3603	86	2.38
35	Worcester	6204[e]	141	2.27
36	Iowa State	11436[b]	255	2.23
37	Washington State	3069	66	2.15
38	Bucknell	1690	36	2.13
39	Tennessee	2622[a]	53	2.03
40	Penn State	11248[a]	222	1.97
41	Drexel	3744[a]	73	1.95
42	Brooklyn Polytech Inst.	6276	121	1.93
43	Case	7950	152	1.91
44	Colorado Mines	4437	80	1.80
45	Louisville	1342	24	1.79
46	Colorado A & M	1805	32	1.77
47	Northwestern	2213[d]	39	1.76
48	Rensselaer	12841[b]	222	1.73
49	Carnegie	8000 est	133	1.67
50	Maine	5100[a]	85	1.67
51	Stevens	6671	111	1.66
52	Oregon State	5498	90	1.64
53	Texas A & M	11026	164	1.49
54	Virginia Polytech Inst.	8002	114	1.43
55	Northeastern	4928	67	1.36
56	College of City of New York	7159	94	1.31
57	Arkansas	2900	36	1.24
58	Oklahoma	6179	76	1.23
59	New Mexico	1395	17	1.22
60	Michigan School of Mines	5219[a]	61	1.17
61	Toledo	1288	15	1.16
62	Louisiana State	3998	46	1.15
63	Texas Tech	2685	30	1.12
64	UCLA	1039	11	1.06
65	Akron	962	9	.94
66	Duke	1282	12	.94
67	Georgia Inst. of Technology	11685	100	.86
68	Southern California	3652[c]	27	.74
69	Clarkson	3444	24	.70
70	Wayne	1585	11	.69
71	Oklahoma A & M	4561	23	.50

NOTE: Mean value = 2.58; Median value = 2.23; σ = 1.43. [a] Includes 1955 graduates. [b] Includes all 1954 graduates. [c] Since 1941. [d] Since 1927. [e] Includes physics and chemistry graduates.

Table 3 Graduates of Other Universities

	No. in Who's Who
Vienna University of Technology	27
Swiss Federal Institute of Technology (Zurich)	27
University of London	25
Technological University of Delft	16
University of Alaska	13
Polytechnic University of Budapest	13
Technical University of Berlin	13
University of Puerto Rico	11
Cambridge University	10
Royal Institute of Technology of Sweden (Stockholm)	9
Czech Technical University (Prague)	9
Norway Institute of Technology (Trondheim)	9
Technical University of Darmstadt	8
Manchester University	8
96 other universities or institutes not in U. S. A. or Canada	192
Total	390

NOTE: The 14 institutions listed had 50.5 per cent of all graduates of universities not in U. S. A. or Canada.

Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Associate Editor*

Atoms-for-Peace Conference

The recently completed UN-sponsored International Conference on the Peaceful Uses of Atomic Energy (Geneva, Aug. 8–20, 1955) marked the start of a new era of international co-operation. With more than 70 nations participating, this conference was probably the outstanding scientific and technical event since the end of World War II.

That the Conference was successful as an international co-operative venture was evidenced by the fact that even Russia lifted its Atomic Curtain. For the first time the Russians spoke freely and even gave details of their industrial 5000-kw power reactor. Among other things, they also gave a brief account of a proposed 100,000-kw atomic power plant that had been announced earlier this year. In areas where they did not present specific papers the Russian scientists usually entered into the discussion periods. Here again, reports indicated, they interchanged atomic data freely with their fellow scientists from other countries.

However, the Geneva Conference seemed to be far and away a United States show. This is probably as it should have been, for it was President Eisenhower's speech before the United Nations General Assembly on Dec. 8, 1953, that gave impetus to the holding of a conference on peaceful applications of atomic energy.

For example, of the 23 different nations that contributed the 474 papers that were presented and discussed, the U. S. delegation was assigned a total of 178 papers on the Conference Agenda. These were chosen from 535 papers originally submitted to the U. N. Advisory Committee for consideration, all of which will be published in the official proceedings of the Conference.

Further, the U. S. papers covered every subject on the Conference agenda, making this country the only one participating to cover the complete range of topics designated for discussion.

While much attention was paid to isotopes, the main emphasis was placed on the generation of useful power from the atom. Representatives from smaller countries and remote underdeveloped areas listened intently to the prospects predicted for atomic power.

For example, the U. S. announced that electricity, produced from nuclear energy, has been used to light and power the town of Arco in Idaho. The experimental

Fig. 1 The Atoms-for-Peace Conference at Geneva closed with the signing of documents turning the United States Exhibit Reactor over to Switzerland for research work on peaceful uses of atomic energy. At the signing ceremony: *Left* to *right*, Walter Boveri, president of Swiss Reactor Corporation which will operate the reactor at Wuerenlingen (Argovei), Lewis L. Strauss, chairman of the U. S. Atomic Energy Commission, Miss Frances Willis, U. S. Ambassador to Switzerland, Prof. Paul Scherrer, chairman of the Swiss Commission of Nuclear Research and head of Switzerland's delegation to the atomic conference, and Willard F. Libby, U. S. Atomic Energy Commissioner. The reactor, shown in the background, was designed and built at Oak Ridge National Laboratory which is operated by Union Carbide and Chemical Corporation for the United States Atomic Energy Commission.

nuclear power plant, known as "Borax," generates more than 2000 kw of electricity. This type of small power plant, it was pointed out, because of simplicity of construction, ease of operation, low cost, and high degree of safety, suggests its suitability for use in remote areas or in conjunction with mining or manufacturing operations.

In Britain, the conference was told, "probably the whole of the additional energy over 1975 requirements will have to come from nuclear sources."

And so the Conference went, leaving but one impression, that: The science of the atom is providing the world with a new and dynamic source of power which if skillfully and co-operatively employed will prove beneficial to the entire world.

The presentation of papers and participation in the scientific discussion were not the only contribution of the U. S. As education and demonstration resources the U. S. delegation provided a full-scale operating swimming-pool research reactor which proved to be a major attraction, technical and popular exhibits, a reference library, and a film program.

In addition to the 183 technical advisers to the U. S. delegation, some 100 American industrial and commercial firms, along with 50 academic, professional, and private educational and research organizations, participated through exhibits in the Conference.

The official U. S. technical exhibit, which many observers rated as the best in the show, provided an integrated story of peacetime atomic-energy development on its technical side, from raw materials through fuel elements, models of reactors, reactor components, chemical processing, instrumentation, the uses of isotopes in biology, medicine, and industry, and basic research.

The Russian display also enjoyed great popularity, probably because it was the first time anyone outside of Russia has had a chance to see any of her atomic developments. Featured at the USSR exhibit were models of the 5000-kw power plant, a research reactor, and an experimental heavy-water reactor.

Of great interest was the United Kingdom exhibit which included models of the Dimple, E443, Dounreay, and Calder Hall reactor types plus a great deal of scientific equipment.

While all the other exhibits shown at the Palais des Nations were of good quality, they didn't have the appeal of the "big three."

The exhibit at the Palais des Expositions was said to be very impressive. Actually it was a trade show. Observers said that the biggest exhibit in area was the British one, which included 28 exhibitors.

France with its 50 exhibitors and the U. S. with 24 were the next most impressive at the show.

Commenting on the Conference in its current semiannual Report to Congress, the Atomic Energy Commission stated: "The Conference . . . . will gather together the largest and most representative group of the world's specialists in nuclear science and the arts of applying atomic energy to human welfare that has ever been assembled. Old lines of scientific communication will be renewed and new ones formed. The collective knowledge of mankind on how to put the atom to work for material progress in all lines will be shared among the technical representatives of the great majority of the people of the world."

From all indications and reports it is a certainty that the conference has lived up to its expectations. It is also a certainty that the engineers and scientists who participated in the Conference have done much to weld the nations of the world together.[1]

Earth Satellite Vehicle

Plans for the construction of a small, unmanned, earth-circling satellite vehicle to be used for basic scientific observations during the forthcoming International Geophysical Year were announced recently by Detlev W. Bronk, Hon. Mem. ASME, and President of the National Academy of Sciences, and Alan T. Waterman, Director of the National Science Foundation. The project, which is entirely scientific in nature, will be sponsored by these two organizations as part of the United States program of participation in the International Geophysical Year. Technical advice and assistance will be provided by the scientists of the Department of Defense who have long been engaged in research on the upper atmosphere. The Department of Defense will provide the required equipment and facilities for launching the satellite.

The program for such a vehicle was stimulated by a resolution passed by the Special Committee for the International Geophysical Year (French abbreviation CSAGI) at its Rome meeting in October, 1954. It is planned that the developmental work be completed in time for a successful launching during the International Geophysical year, which is a period set aside during 1957 and 1958 for world-wide observations in the fields of the earth sciences by some 40 nations. The planning for this period of intensive research on an international basis is under the sponsorship of the International Council of Scientific Unions (ICSU) which established CSAGI to plan, organize, and direct the co-operative effort. Each participating country is planning and developing its own program for this period, and the results obtained will be made available to the scientists of the world.

In its resolution, the Committee stressed the great importance of observations of extraterrestrial radiations and geophysical phenomena for extended periods of time. The Committee's recommendation urged that participating nations give consideration to the construction of small satellite vehicles, instrumented to provide such data as may be feasible from outside the earth's atmosphere.

The chairman of the U. S. National Committee for the International Geophysical Year has formally notified the president of CSAGI that the United States' program of participation now includes definite plans for the launching of small satellites during that period.

The atmosphere of the earth acts as a huge shield against many of the types of radiation and objects that are found in outer space. It protects the earth from things which are known to be, or might be, harmful to human life, such as excessive ultraviolet radiation, cosmic rays, and those solid particles known as meteorites. At the same time, however, it deprives man of the opportunity to observe many of the things that could contribute to a better understanding of the universe. In order to acquire data that are presently unobtainable, it is most important that scientists be able to place instruments outside the earth's atmosphere in such a way that they can make continuing records of the various

[1] A report on the Conference by J. Foster Petree, European Correspondent for Mechanical Engineering, who was in attendance at Geneva, appears in this month's "European Survey," pages 904–911.

properties about which information is desired. In the past, vertical rocket flights to extreme altitudes have provided some of the desired information, but such flights are limited to very short periods of time. Only by the use of a satellite can sustained observations in both space and time be achieved. Such observations will also indicate the conditions that would have to be met and the difficulties that would have to be overcome, if the day comes when man goes beyond the earth's atmosphere in his travels.

The satellite itself will orbit around the earth for a period of days, gradually circling back into the upper atmosphere where it will eventually disintegrate harmlessly.

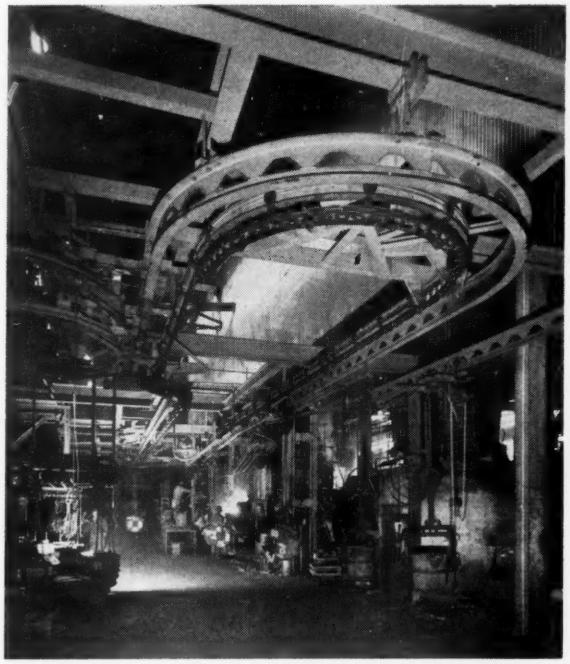

Fig. 3 Pouring ladles travel to the pouring floors on a Trambeam monorail. Switches, like the one above, transfer the ladles to other Trambeam monorails that serve each pouring floor.

Streamlined Charging Cycle

A HIGHLY mechanized charging system to insure constant, uniform charging throughout the 16 hours of pouring each day, is being used by the Cleveland Works of National Malleable and Steel Castings Company, Cleveland, Ohio.

Heart of the charging system for each battery of two cupolas, is a "merry-go-round" located about 50 ft in back of the cupolas. This is a continuous, circular conveyer system installed in a pit. Nine cone-bottom Whiting charging buckets travel on this conveyer and pass under the hoppers containing coke, limestone, and metal. One bucket of coke and limestone and two buckets of metal are used for each 4-ton charge.

One operator controls all of the loading from his

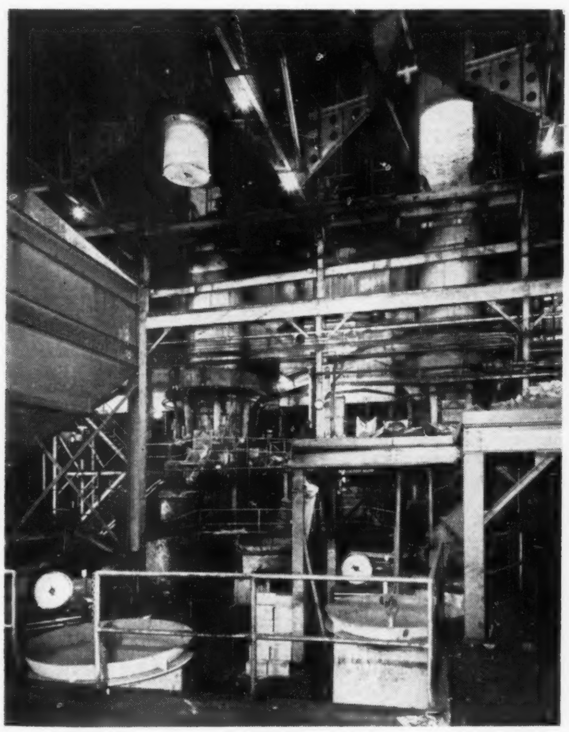

Fig. 2 Each of the 108-in. Whiting cupolas is served by its own Whiting horseshoe charger. Here a cone-bottom bucket is being placed in the wishbone support for unloading.

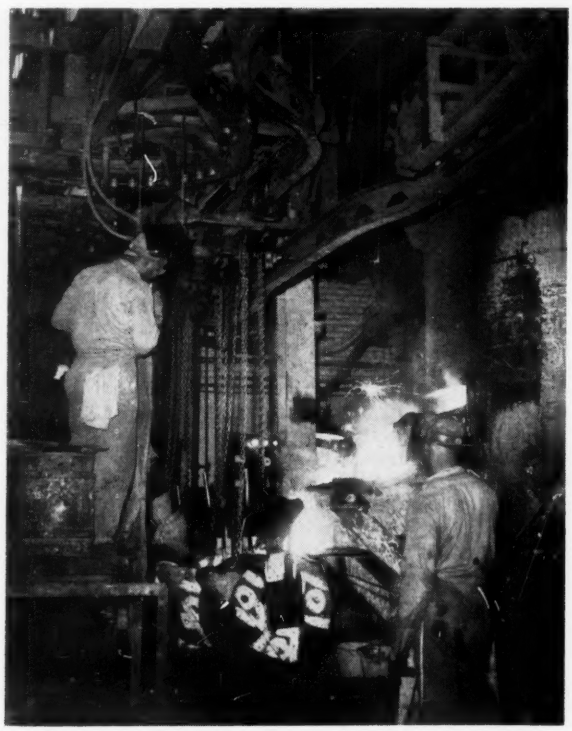

Fig. 4 Ladle handling is mechanized, too, at National Malleable. Pouring ladles (being filled, above) are traveling to the pouring floors on a Trambeam monorail.

station in the center of the pit. The scales under the hoppers are placed so that the operator and craneman can read them from their control stations. When a loaded bucket reaches one of the pickup points, the same operator controls the Whiting horseshoe charger that hoists the bucket, carries it into the wishbone support in the cupola, discharges the load, and returns the bucket to its position on the conveyer. Each of the cupolas is served by a $7^1/_2$-ton capacity Whiting horseshoe charger.

The melting department of this foundry consists of two such batteries of cupolas. One, installed in 1930, has two 120-in. Whiting cupolas. The other, installed in 1953, has two 108-in. Whiting cupolas. Only one cupola of each size is used each day, and 55 to 65 tons of malleable automotive castings are poured each hour.

2,400,000-Lb Per Hr Boiler

The Consolidated Edison Company of New York announced recently that it has contracted with The Babcock & Wilcox Company for B&W to design and build the largest boiler in the world to produce steam for the utility's Astoria, Queens, station. The unit will have a capacity of 2,400,000 lb of steam per hr and will consume over 50 carloads of coal a day or enough to heat about 2000 average homes for a full year, the announcement said.

Erection of the huge boiler, which will produce sufficient steam to generate between 300,000 and 375,000 kw of electricity, will start in early 1957, and it is scheduled to begin operating in the fall of 1958. It will have a design pressure of 2500 psi. A feature of the design, according to B&W, is that the boiler will be equipped to burn either coal, oil, or natural gas, or a combination of these fuels.

The unit will be of the twin-furnace type in which the steam is brought up to maximum temperature of 1050 F in one furnace, then goes through the turbine where some of the energy is extracted, and returns to the other furnace for reheating to 1000 F, thus making more efficient use of the heat in the fuel. The steam drum will be built at B&W's Boiler Division works in Barberton, Ohio. It will be 101 ft long and will weigh 235 tons, the longest and heaviest ever built.

Protective-Coating Penetration

A method to determine the degree of penetration of a fish-oil-based protective coating into the rust layers of steel specimens was developed by Battelle Memorial Institute, Columbus, Ohio, for the Rust-Oleum Corporation of Evanston, Ill.

Attempts to obtain this information, using x-ray techniques, had not proved successful. It was therefore agreed that preparation of a radioactive vehicle of the same composition as Rust-Oleum's standard vehicle might provide the means for determining the degree of penetration of the product into rust layers by using standard radiographic and autoradiographic techniques.

Preparation of Radioactive Coating

Samples of Rust-Oleum Number 769 Damp Proof Red Primer, the vehicle used in the preparation of this primer, vehicle solids, and raw fish oil used in the preparation of this vehicle were submitted to Battelle by the company.

A major component that is common to all fish oils and independent of the source is glycerol in the form of triglycerides. It therefore was decided to attempt to replace the glycerol portion of the oil with radioactive C^{14}-labeled glycerol. This presumably could be done by obtaining the fish-oil fatty acids by the saponification of fish oil, followed by re-esterification of these fatty acids with C^{14}-labeled glycerol, thereby obtaining a radioactive, reconstituted fish oil.

Eleven batches of reconstituted fish oil were synthesized and checked, in the laboratory, against the original oil. Of these, two were submitted to the company for evaluation. These samples were analyzed with an infrared spectrometer, and each compared favorably with the infrared spectra of the original fish oil.

It was observed that, within the limits of the instrument, the reconstituted oils were nearly identical to the original oil.

The company also evaluated the oil samples submitted and found the reconstituted oils to be entirely satisfactory and to react under standard-treatment processes in a manner identical to that of the original fish oil. In regard to drying time, workability, and other physical characteristics, the reconstituted oils matched the original fish oil.

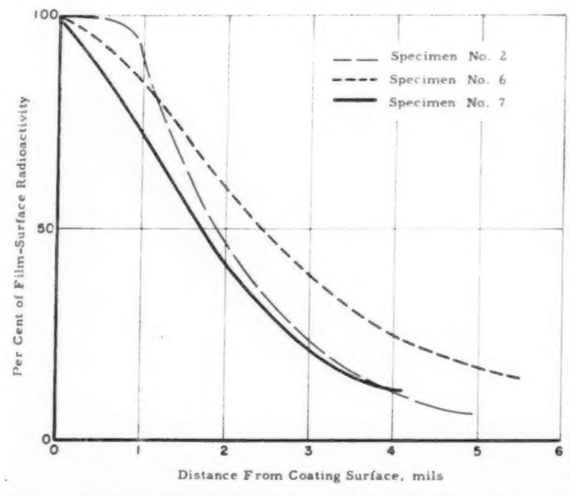

Fig. 5 Radioactivity as a function of depth in protective coating and rust film for samples with one coat of Rust-Oleum protective coating

This report from the company indicated that a radioactive protective coating could be prepared, since the substitution of C^{14}-labeled glycerol for normal glycerol would not affect the chemical reactions involved.

Five small-scale esterifications were made to perfect the techniques necessary for preparing small batches of reconstituted fish oil. When the techniques were perfected, a batch of 26.6 grams of radioactive fish oil was prepared.

This radioactive fish oil was then processed into fish-oil vehicle and blended with pigment by the company to yield one pint of radioactive coating.

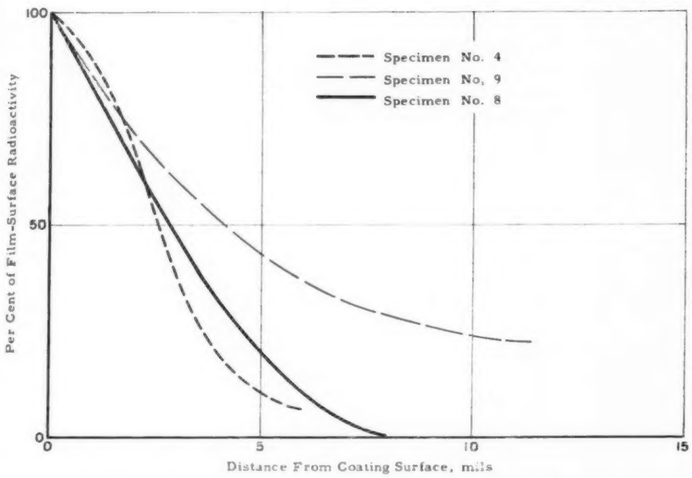

Fig. 6 Radioactivity as a function of depth in protective coating and rust film for samples with two coats of Rust-Oleum protective coating

Penetration Demonstration

Two alternative methods, autoradiography and lapping, appeared applicable to the problem of demonstrating the penetration of the vehicle component into rust layers on steel.

However, the lapping technique appeared to be much more promising, because of the low concentration of C^{14}. In this technique the radioactivity of the surface of a painted specimen is determined, then a thin layer of the surface is removed by lapping, and the radioactivity of the newly exposed surface is measured. This procedure is repeated until the protective coating and rust are removed and a bare steel surface remains. The concentration of the radioactive component in layers of the protective coating and rust film at various depths is thus determined.

Rusted steel plates, supplied by the company, were used to prepare specimens for examination. Two plates, $^1/_{16}$ in. and $^1/_{32}$ in. thick, were used. Disks, 1 in. in diam, were stamped from the plates and mounted onto $^1/_4$-in-thick steel cylinders. The disks were mounted in this manner so that they could be used in the radioactivity detection apparatus.

The rusted surfaces were wire-brushed and coated by a company representative in accordance with the directions given on a can of the product purchased locally. The coated specimens were allowed to dry in the laboratory for approximately two weeks.

After drying, a specimen was mounted in a lapping fixture that made possible controlled removal of the surface layer. Crocus cloth was used as an abrasive. Micrometer measurements were made before and after each lapping cycle to determine the exact thickness of the layer removed.

Radioactivity measurements of the specimen surface were made with both an end-window Geiger-Mueller tube and with a gas-flow proportional counter. As the coating and rust layer was removed by lapping, the residual radioactivity decreased and the precision of measurement with the Geiger-Mueller tube also decreased. It therefore became necessary to use the gas-flow proportional counter to verify the presence of the radioactive component in layers close to the bare steel surface where the radioactivity was relatively low.

The microscopic examination of specimen cross section showed considerable irregularity in the metal-rust and rust-protective coating interfaces. For this reason the boundaries between the various layers could not be differentiated with precision. The visual examination of these cross sections permitted the delineation of six zones: Protective coating film; protective coating film with some rust; mixed rust and protective coating; rust with some protective coating; mixed, Rust-Oleum vehicle, rust, and metal; and metal. The irregularities of these zones must be considered in the evaluation of the penetration of the fish-oil vehicle component of the product.

From the results of the lapping experiments it may be concluded that the fish-oil vehicle of the Rust-Oleum protective coating does penetrate the rust layer to the metal surface in measurable quantities. In general, the shape of the curve for radioactivity versus distance from surface is similar for all specimens. The curves indicate a moderate decrease of radioactivity, and hence fish-oil-vehicle concentration, through the coating and rust film. As the metal surface was approached, a leveling off of the concentration was observed. At the metal surface, where no rust was observed, no radioactivity was found. Within 0.5 mil of the bare metal surface, in the area designated "mixed, Rust-Oleum vehicle, rust, and metal" approximately 3 per cent of the total fish-oil vehicle of the Rust-Oleum product was found. The precision of the radioactivity measurements with a Geiger-Mueller tube in this layer was poor. However, measurements with the gas-flow proportional counter in this region

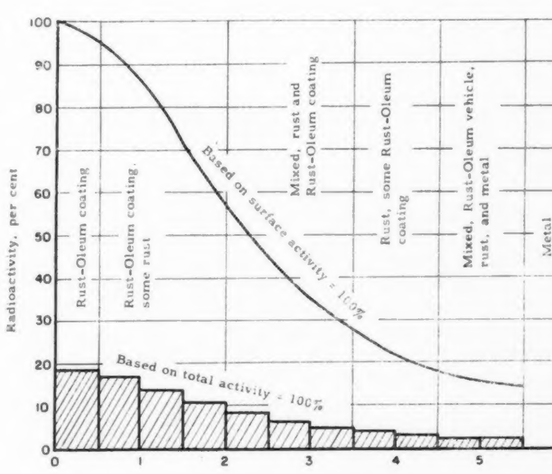

Fig. 7 Composite curve showing penetration of radioactive vehicle component of Rust-Oleum protective coating into rust layers on steel

verified the presence of sufficient radioactive fish-oil vehicle to substantiate the data obtained with the Geiger-Mueller counter. As long as some rust could be observed on the surface of the metal, the gas-flow proportional counter detected a measurable amount of radioactivity.

Atomic Energy Commission Report

According to the Eighteenth Semiannual Report of the Atomic Energy Commission the six-month period from January to June, 1955, saw a rapid advance in the atoms-for-peace program around the world.

In the past 60 days of this period, 27 other nations entered into agreements for co-operation with the United States in developing the civil uses of atomic energy. To supply the fuel that would eventually be required for research reactors under these many agreements, the President authorized adding 100 kg (220 lb) of uranium 235 to the original 100 kg set aside in late 1954 for atoms-for-peace programs. This was announced by the chairman of the Commission in an address to the Overseas Press Club, New York, N. Y., in June. The President also enlarged the scope of the program in two statements. At the Associated Press luncheon in New York, April 25, the President advocated construction of a nuclear-powered merchant ship and its use in demonstration cruises about the world to portray the peaceful uses of atomic energy. In May, the Exeucutive Branch placed before the Congress requests for funds for the atomic-powered-ship program. At Pennsylvania State University in mid-June, the President in a speech proffered financial aid to other nations in the construction of research reactors, and training and technological aid in the development of power reactors by friendly nations.

Extensive preparations were made for the contributions of the United States to the International Conference on Peaceful Uses of Atomic Energy at Geneva in August. The conference originally was proposed by this nation, and its management was assumed by the United Nations last December.

Various training courses were inaugurated by the Atomic Energy Commission for technical men of other nations. Libraries of all the unclassified technical material published by the Commission were authorized for presentation to 23 other nations at their request.

The other activities of the Atomic Energy Commission continued at a growing rate and with increasing effectiveness.

Domestic production of uranium ore and concentrates during the first six months of 1955 reached record levels—making the United States one of the world's leading uranium producers—while production from foreign sources continued to increase. Greatly accelerated exploration activity by private industry resulted in the discovery of potentially large deposits of uranium ore in presently nonproducing areas of the Colorado Plateau. Research and process development studies on economic methods for recovery of uranium from its ores continued.

Increased availability of raw materials, along with the start-up of new plant capacity, resulted in new high levels in the production of special nuclear materials, at lower unit cost.

All of the new gaseous diffusion facilities authorized in 1952, except that at Portsmouth, Ohio, were completed and contributing to production. Construction at Portsmouth proceeded on schedule. New facilities at the Hanford and Savannah River reactor sites began operation during this period. Design of additional feed materials processing facilities at Fernald, Ohio, St. Louis, Mo., and Paducah, Ky., progressed satisfactorily, and construction at the three sites began during March.

Largely as a result of this progress in construction, capital investment in atomic-energy plant facilities was estimated to have reached about $6.6 billion before depreciation reserves.

A prominent event in the weapons research and development program was a successful test series (Operation TEAPOT) concluded at the Nevada Test Site from February 18 to May 15. The Federal Civil Defense Administration concluded its "Operation Cue" in connection with the 13th nuclear test of this series. This was the most comprehensive civil-defense exercise held in Nevada to date.

The Commission's program of developing reactors for industrial and military power and for naval and aircraft propulsion made greater strides during this period than in any earlier half-year. For example, the AEC moved toward greater participation by industry in advancing the development of competitive nuclear power. Toward this end, the Commission set up an expanded program for making classified information available to industry, established a classified schedule of prices and charges for materials furnished by the AEC, and prices for special nuclear material produced in power reactors. Four industrial proposals were received for the power-demonstration reactor program. The number of industrial participation groups was increased from 18 to 25, bringing the number of individual firms now in the program to 81.

Major construction work is in progress at the Shippingport, Pa., site of the nation's first civilian nuclear power plant. This 60,000-kw version of the pressurized-water reactor will be operated by the Duquesne Light Company of Pittsburgh, Pa.

The first nuclear-powered submarine, the USS *Nautilus*, got under way on nuclear power on January 17, while the second such submarine, the USS *Seawolf*, was launched on July 21 at the Electric Boat Division, General Dynamics Corporation, Groton, Conn. A 100-hr full-power test of SIR Mark A, the land-based prototype of the engine designed to propel the *Seawolf*, was successfully completed. Surplus steam from SIR Mark A will be channeled into a 10,000-kw turbine-generator installed and operated by the General Electric Company, at no cost to the government. The resulting electrical output will be sold by AEC as a demonstration of commercial usage of atomic-produced electricity.

Design and development work on the large ship reactor continued at the Bettis Plant by the Westinghouse Electric Corporation under AEC contract. The first phase of the Army's Package Power Reactor program was completed, and the Aircraft Nuclear Propulsion program accelerated with the promise of nuclear-powered flight considerably brightened.

British Nuclear Power Company

A group of firms who either have had close association with the United Kingdom Atomic Energy Authority in the design and construction of the Calder Hall Atomic Power Station, or in experimental reactors for Harwell, or

who have special experience and facilities for such work, are associated with a recently incorporated separate company which will concentrate on the research, design, and construction of nuclear-power stations.

Registered with an authorized capital of one million pounds, The Nuclear Power Plant Co. Ltd. has its registered office at Heaton Works, Newcastle-upon-Tyne. The design headquarters is Booths Hall, Knutsford, Cheshire.

The associated companies are: C. A. Parsons & Co. Ltd., Newcastle-upon-Tyne; A. Reyrolle & Co. Ltd., Hebburn-on-Tyne; Head, Wrightson & Co. Ltd., Thornaby-on-Tees; Sir Robert McAlpine & Sons, Ltd., London; Whessoe Limited, Darlington; Strachan & Henshaw Ltd., Bristol; Alex. Findlay & Co. Ltd., Motherwell; Clarke, Chapman & Co. Ltd., Gateshead-on-Tyne.

Parsons, Reyrolle, Whessoe, Strachan & Henshaw, and Alex. Findlay have gained valuable experience in the development of the Calder Hall Power Station. Head, Wrightson have had wide experience in the design and manufacture of modern heat-exchange equipment; they have been engaged for some time in the design and construction of various types of reactors at home and abroad; they are also designing and building the large heavy-water plant in New Zealand. Clarke, Chapman have wide experience in steam-raising and allied equipment. McAlpines have been outstandingly successful in the civil-engineering field, particularly in the construction of power stations for the Central Electricity Authority.

The combination of these eight firms will enable The Nuclear Power Plant Co. Ltd. to design and construct atomic power stations in any part of the world.

The Parolle Electrical Plant Co. Ltd. (joint proprietors—Parsons Reyrolle) who have been associated with the Atomic Energy Authority in the design and construction of the Calder Hall Power Project, will co-ordinate the activities of the eight co-operating companies in design and construction. They will also be responsible for site services.

Small Gas Generator

A GAS generator weighing less than 3 lb and only about 4 in. long and 3 in. in diam, yet capable of producing about 850 jet horsepower, has been developed by the General Electric Company's Aircraft Gas Turbine Development Department, Cincinnati, Ohio.

The gas generator was developed for application to guided-missile propulsion systems, but it is said to be ideal for many applications where a portable, lightweight, and reliable source of energy is required.

Using no moving parts, the gas generator is designed to convert liquid hydrogen peroxide into a high-pressure, high-temperature gas stream of free oxygen and steam. This gas stream, or jet as it is called, may then be directed against a turbine wheel and the rotative power thus generated may be used in the same manner as any turbine-generated power. Jet horsepower, it was explained, is a term used in the rocket field to express the energy in the high-velocity jet.

Department engineers say jet horsepower from the same unit has been varied from as little as 50 to about 1800 by simply adjusting the incoming liquid-flow rate, and that operating life requirements from a few seconds to hours can be designed into a unit.

Fig. 8 This gas generator, weighing less than 3 lb, can produce about 850 jet horsepower

Possible industrial applications of the gas generator include use as a source of energy for rotating machinery, as a thrust-simulating device for static tests of airplane or missile models, or as a quick and reliable source of steam.

Electric-Energy Production

ELECTRIC-ENERGY production in the United States reached an all-time record 503,228,956,000 kwhr for the year ending June 30—the first time ever that such figures topped the half-trillion mark—the Federal Power Commission reported recently in its "Production of Electric Energy in the United States" series.

The 12-month total was 1.1 per cent over the record set by the 497,963,360,000 kwhr total for the 12 months ending May 31, and 11.0 per cent over the 453,517,681-000 kwhr total for the year ending June 30, 1954.

Production of energy during June totaled 44,234,391-000 kwhr, a record for that month and an increase of 13.5 per cent over the 38,968,795,000 kwhr produced during June, 1954.

Energy produced by water power plants of electric utilities was 9,709,237,000 kwhr, an increase of 1.3 per cent above June, 1954, figures. As a proportion of the June total, water-power output decreased from 24.6 per

cent last year to 21.9 per cent this year. Production by fuel-burning plants in June was 17.5 per cent above that for June, 1954.

Cumulative production for the first half of 1955 was 258,257,439,000 kwhr, including 58,390,057,000 kwhr by hydro plants and 199,867,382,000 kwhr by fuel-burning stations. The six-month total registered a gain of 13.9 per cent: hydro production increased 2.1 per cent and fuel 17.9 per cent over the like 1954 period.

Reports received by the FPC indicated that the installed capacity of generating plants in utility service totaled 107,617,233 kw at the end of June, a net increase of 1,292,955 kw during the month. The June 30 capacity indicates a 1955 first-half net addition of 5,024,823 kw from the final total of 102,592,410 kw in service Dec. 31, 1954, and a gain of 12,308,260 kw or 12.9 per cent from the June a year earlier.

Industrial production, including generation by railway and railroad plants, was 6,490,434,000 kwhr in June, an increase of 7.2 per cent over the June, 1954, figure. Total industrial generating capacity was 16-085,165 kw at the end of June.

Combined utility and industrial production was 50-724,825,000 kwhr, 12.7 per cent above the same month last year; and for the year ending June 30, was 10.1 per cent above the same period a year earlier. Utility and industrial generating capacity totaled 123,702,398 kw on June 30, 1955.

Portable Pyrometer

A PORTABLE pyrometer that looks like a microphone on the end of a long pole has solved the problem of accurately measuring high temperature of metals and refractories when surrounded by cooler air.

With the Land Surface Pyrometer, the Fielden Division of Robertshaw-Fulton Controls Company, Philadelphia, Pa., believes it has the answer to a difficult temperature-gaging situation that has perplexed the steel, nonferrous-metal, plastics-molding, die-casting, glass, and metal-treating industries for years.

According to the company, the instrument will give accurate temperature readings within 0.5 per cent, whereas contact thermocouples, formerly relied upon for measuring heated material in cool surroundings, have an accuracy of about 5 per cent.

The Land Surface Pyrometer is suitable for measuring "spot" temperatures in a range from 100 F to 2400 F, and may be used for oxidized steel or cast iron, many oxidized nonferrous metals, painted surfaces, and others, regardless of their emissivity.

The measuring head of the instrument is mounted on a telescopic arm, which can be extended to a length of 9 ft. It is normally connected by a trailing lead to a portable millivolt meter that is calibrated in temperature degrees. Used in this manner, the company, said, it requires no external power supply, and readings from the pyrometer are obtained five seconds after the head is placed upon the hot body.

Temperature readings of high accuracy obtained with the Land Surface Pyrometer are made possible by the instrument's unusual design which, according to the company, produces near-perfect "black-body" radiation. This black-body radiation is found in and between the framework of atoms that comprises the heated material, and also holds the key to its exact temperature.

Fig. 9 Engineer samples temperature of hot steel billet, using new portable Land Surface Pyrometer. Instrument head, mounted on adjustable pole, is applied to hot body. Accurate temperature is given five seconds later on millivoltmeter calibrated in degrees (shown on floor).

Applied to the surface of a hot body, the instrument head, which is concave in shape, closes off a portion of the heated material, forming a uniform temperature enclosure. A near-perfect reflector, created by a heavy gold plating inside the instrument head, actually reproduces the surface conditions of the hot material. Black-body radiation trapped within this uniform temperature enclosure is then sampled through a small fluorite window, which is transparent to most of the infrared spectrum and measured by a sensitive thermopile.

Used in determining the temperature of a hot steel billet, for example, the pyrometer will measure the heat at $^3/_{16}$ in. below the surface, rather than at the actual surface of the metal. With refractories, the depth of measurement is about $^1/_{16}$ in.

The announcement cautioned that the instrument is not intended for continuous measurement inside furnaces.

Lightweight Portable Boring Machine

FINISH-BORING the holes for coupling bolts in heavy castings or in forgings such as ships' propeller shafting can involve an inordinate amount of lifting and shifting if the job has to be taken to a machine; and, if the bolts are to be a close fit, the holes in both flanges must be

bored or reamed in one operation, which will certainly be awkward to arrange, and may be impossible, on any ordinary shop machine. Moreover, in shaft flanges, and in castings intended for high-pressure duties, the bolts are usually so close to the body metal that a fixed drilling or boring machine cannot get at the holes.

To overcome these difficulties the Buma Engineering Company, Limited, Robson Street, Newcastle-upon-Tyne 6, England, have developed a portable electrically-driven boring rig, light enough to be carried (for a short distance) by one man of fairly robust physique and clamped in position on the work, and so compact that it can operate with the center of the boring bar only $1^7/_8$ in. from the surface to which the machine is attached.

The boring bar carries, in a detachable holder, a single-point tool with a tungsten-carbide tip, adjustable to bore from 2.2 in. to 4.2 in. diam. The maximum depth of bore is $10^3/_4$ in.

The $^1/_2$-hp driving motor is mounted on the main casting, which carries the boring bar in Timken taper-roller bearings, and the drive is transmitted by a single V-belt and a pair of three-step cone pulleys to a worm and wheel, and thence by a shaft to a gearbox containing three spur gears, giving speeds of 180, 320, and 460 rpm. A feed as fine as 0.0025 in. per revolution is obtainable. A worm and wheel in the same gearbox drive the feed nut.

The tool is centered in the hole by three radial bars in the boring head, which can be extended or retracted by operating a handwheel on the gearbox; and for setting the tool to the correct diameter of cut there is a special fixture with a built-in micrometer.

A small flywheel on the motor assembly has on its inner face a diamond-impregnated bronze ring for grinding the tool, which is held for the purpose in a fixture secured to a lug on the shaft housing. The tool is inserted in this fixture, adjusted for angle by the use of a setting gage which is part of the equipment, and brought up to the surface of the ring. The base of the main casting has grooves and bolt holes for attachment to a saddle or other support. For use on shafting, the saddle has a wide V slot on the underside and is held on the shaft by a double-roller chain, with a quick-release tightening screw.—J. F. P.

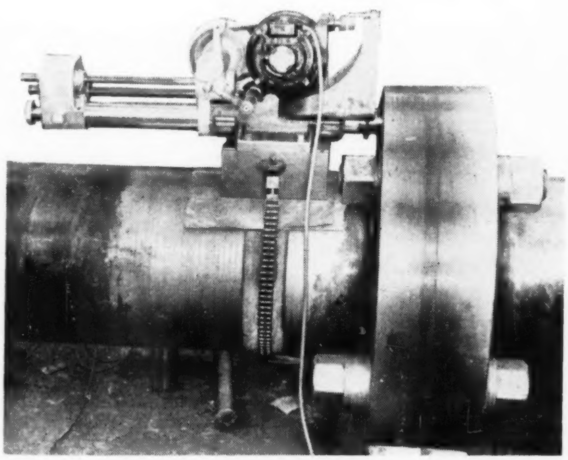

Fig. 10 Buma Engineering Company's portable electrically driven boring rig

Water Problems in Power Generation

(*Continued from page 885*)

zero. The engineering adventure through the Looking-Glass stands to profit from even a slight increase in this ratio to, let us say, 0.1. In relation to the many millions of dollars currently committed to the development of the supercritical boiler, it would seem conservative to spend some modest sum of the order of $100,000 to find out how water and various metallic materials of construction and the products of their interaction do behave in contact with each other under the conditions of temperature and pressure existing not only in the boiler, but also in the turbine.

This is not a responsibility which should be shouldered alone by the manufacturer of the boiler or the turbine, or by the utility company contemplating the purchase of a unit. Instead, the need for basic data obviously could be met to the advantage of all concerned by a program of co-operative research. Such a program might well be conducted under the sponsorship of the Joint Research Committee on Boiler Feedwater Studies.

Havelock Ellis once described civilization as "the process of exchanging one nuisance for another." There is reason to believe, however, that he did not recommend a return to Paleolithic standards of living. Nor should the preceding statement of new problems possibly appearing in place of the old be construed as merely reactionary opposition. In appraising the possibilities of the supercritical pressure boiler it is salutary to remember that James Watt once inveighed against the upstart idea of increasing boiler pressures to 100 psi.

We do say that it is not enough to think of water as merely a material for converting heat energy into mechanical energy. Pressure and temperature and steel and water and the small amounts of various substances which will be present in the water by accident or by intention comprise an active chemical system likely to take us by surprise as we step through the Looking-Glass.

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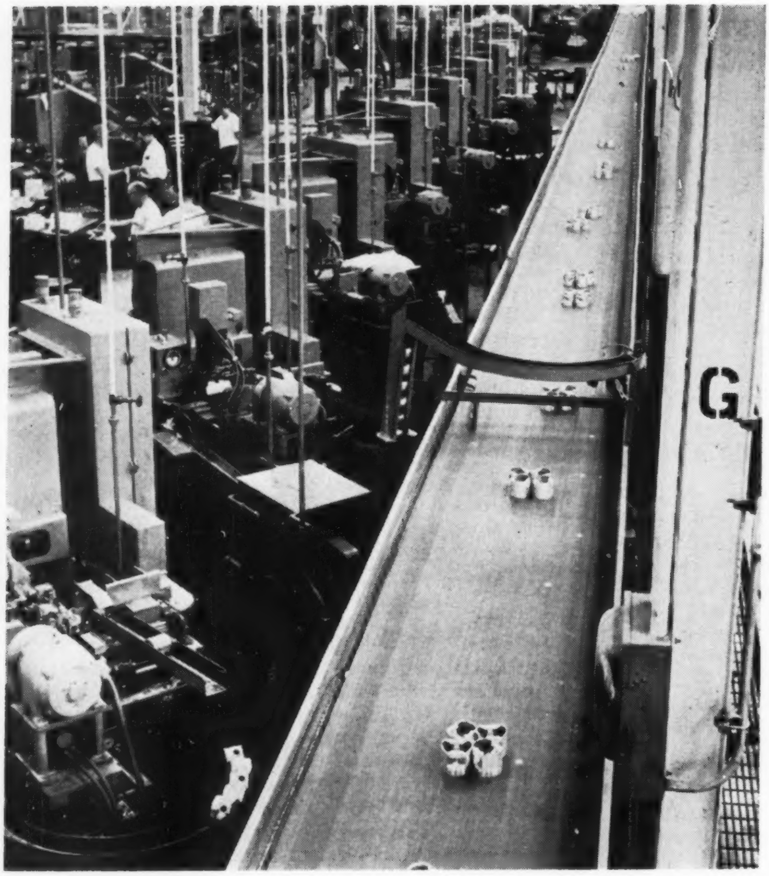
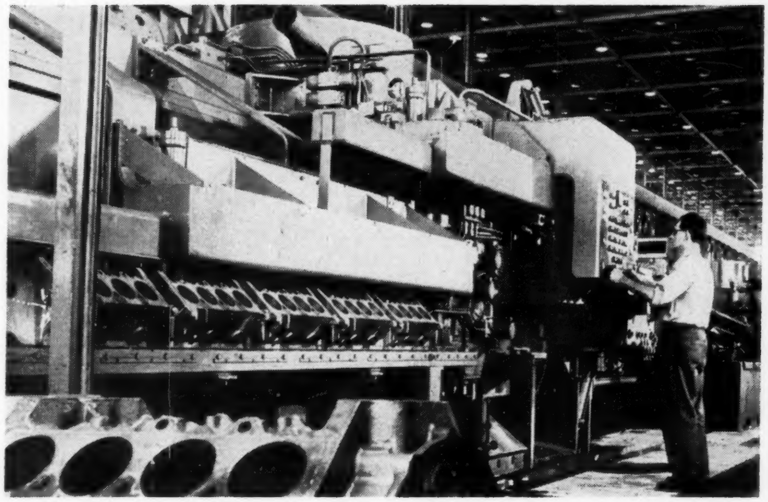


Completely Automatic Piston Operation. Part of the 360-ft conveyer belt in Plymouth's new V-8 Engine Plant which transfers the pistons from the milling operation to the plating tank for tin-plating. The entire piston-line operation, including the gaging, conveyer, and unloading devices, is completely automatic. The pistons are fed to this conveyer on their "heads" by chutes which lead from the milling machines located at the left of the conveyer. Opened by Plymouth Division of Chrysler Corporation, the plant is said to be "the most advanced automobile engine manufacturing operation in the world." Situated on Mound Road in northeast Detroit, Mich., the plant will have an eventual capacity of 3000 engines a day. Currently it is producing about 600 engines a day in accordance with a planned schedule. The sprawling one-story plant, built in 1951 and obtained by Chrysler Corporation in the purchase of the Briggs Manufacturing Company, has a total floor space of 534,059 sq ft. Plymouth added about 71,000 sq ft to the building at a cost of about $1,000,000.

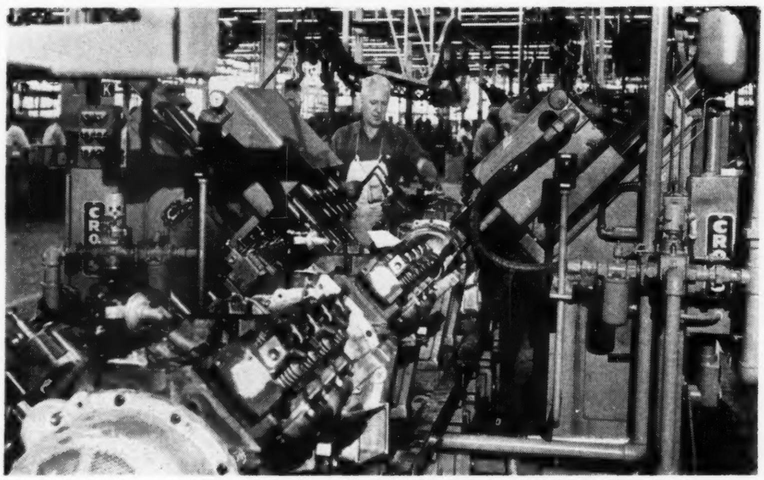
Plymouth's New V-8 Engine Plant . . .

. . . goes into operation

Electric "Detecto" Panels. Overhead view of one of the four cylinder-head lines in Plymouth's new V-8 Engine Plant shows operator on the bridge controlling the line's flow. At his back are electric Detecto panels which pin-point the exact position of any machining trouble along the line. This is accomplished by inserting an electric "pencil," located at the side of each panel, into small contact holes placed in rows along the panel face corresponding to each machine's position. When a "breakdown" occurs along the line, each hole is punched until a light flashes above the panel indicating the trouble. This process is among the many "firsts" introduced by the new V-8 engine operation.



World's Largest Broach. Plymouth's new plant includes this mammoth Cincinnati broach, the largest machine of its type in the world. It is exactly 59 ft long, 19 ft wide, and 12 ft high. Located at the beginning of the cylinder block line, the machine, along with a slightly smaller model, completely broaches the engine block in eight operations.



560-Ft Automatic Assembly Line. Typical of the new plant's automatic assembly line is this horizontal nut running machine. The entire operation is 560 ft in length, has one block line and two head lines, and contains 72 separate assembly operations. When in full production, $2^1/_2$ engines will roll off the line every minute.

Automatic Engine Testing. One of the many new innovations used in the new V-8 engine plant is the automatic engine test. Following the electrostatic painting process, the engines are moved by conveyer to test stands where they are fed oil, water, and natural gas automatically and run for 20-min test cycles. Upon completion of the test cycle, the engines are moved to the storage area ready for shipment.

European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] *Mem. ASME, European Correspondent*

Entrance to Palais de Expositions, scene of "Atoms for Peace" commercial exhibit held during the International Conference on the Peaceful Uses of Atomic Energy, in Geneva, Switzerland. *(United Nations photo.)*

The Atomic Energy Conference in Retrospect

"The Conference has succeeded beyond our greatest expectations." This was the opinion which Prof. Walter G. Whitman, its Secretary-General, expressed in reply to a personal question on the afternoon of Friday, August 19—24 hours before the International Conference on the Peaceful Uses of Atomic Energy in Geneva was due to close—and he confirmed it with emphatic detail in his CBS broadcast on August 21. It is an opinion which appears to be shared by all who took part in this great convention, the potentialities of which for the good of humanity are such that it can hardly be paralleled by any single event in history, written or not, except perhaps the discovery of the art of making fire, if only its lessons are heeded. It may be, as many critical observers considered, that it brought to light little that was not known already to the scientists, but merely revealed how comparatively widespread was much of the knowledge that some of them had believed to be very much otherwise; certainly, it transpired that the atomic researchers of several countries had advanced a long way toward the same objectives, quite independently of each other. That, however, as has been pointed out by commentators, merely emphasizes the folly of attempting to set bounds to the spread of scientific knowledge, and shows how much better it is to adhere to the ancient principle that science knows no frontiers.

Opening Address

The President of the Conference, Homi J. Bhabha, in his opening address on August 8, summed up very neatly the growth in the energy requirements of mankind. In a broad view of human history, he said, it was possible to discern three great epochs; the first marked by the emergence of the early civilizations in the valleys of the Euphrates, the Indus, and the Nile, the second by the industrial revolution, and the third by the discovery of atomic energy. All the ancient civilizations were dependent on the muscle power of slaves, but a man, in an

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Partial view of the audience of scientists at the opening meeting of the International Conference on the Peaceful Uses of Atomic Energy in Geneva, Switzerland. (*United Nations photo.*)

8-hr day of hard physical labor, could hardly turn out more than half a kwhr of useful work. The total consumption of energy in the world had increased "in a staggering manner." Taking an appropriately large unit, denoted by Q, to equal a million million million Btu, corresponding to the consumption of some 33,000 million tons of coal, it was estimated that, in the $81^{1}/_{2}$ centuries after Christ, some $9Q$ of energy were consumed—an average rate of under half a Q per century. But the actual rate in 1850 was probably about $1Q$ per century and it continued to increase. It appeared that, by 1950, another $5Q$ might have been consumed, while the rate had then risen to $10Q$ per century. The total economically recoverable world reserves of coal, oil, gas, and oil shale might be equivalent to something under $100Q$, though some had put the figure at less than $40Q$. It was probable, therefore, that those reserves would be exhausted in under a century. It had been estimated, however, that the recoverable world reserves of uranium and thorium contained some $1700Q$. If that was so, atomic energy could insure to the entire world a constantly rising standard of living for very many decades, and possibly for several centuries.

Seen here *left* to *right* at the rostrum of the Palais des Nations Assembly Hall for the opening of the Conference are: Max Petitpierre, President of the Swiss Confederation; U. N. Secretary-General Dag Hammerskjold; Dr. Homi J. Bhabha of India, President of the Conference; and Prof. Walter G. Whitman (United States), Conference Secretary-General. (*United Nations photo.*)

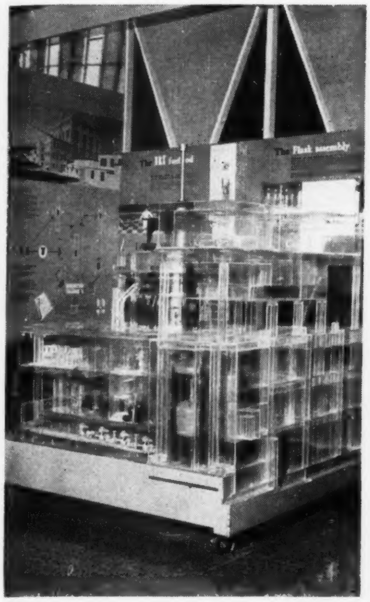
Dr. Bhabha's address had been preceded by a short speech of welcome by Max Petitpierre, the President of the Swiss Confederation, in which he recalled that it was almost

U. S. "Swimming-Pool" Reactor. Swimming-pool-type reactor shown in operation at the "Atoms for Peace" Exhibition in Geneva proved to be one of the main features during the Conference. An average of 5000 daily visitors viewed the reactor at the exhibit. Here a typical crowd throngs the reactor building, listening to the multilingual explanations given by specially trained "atomic" guides. The reactor was built at Oak Ridge Laboratory which Union Carbide operates for AEC.

Nuclear Exhibits Featured During . . .

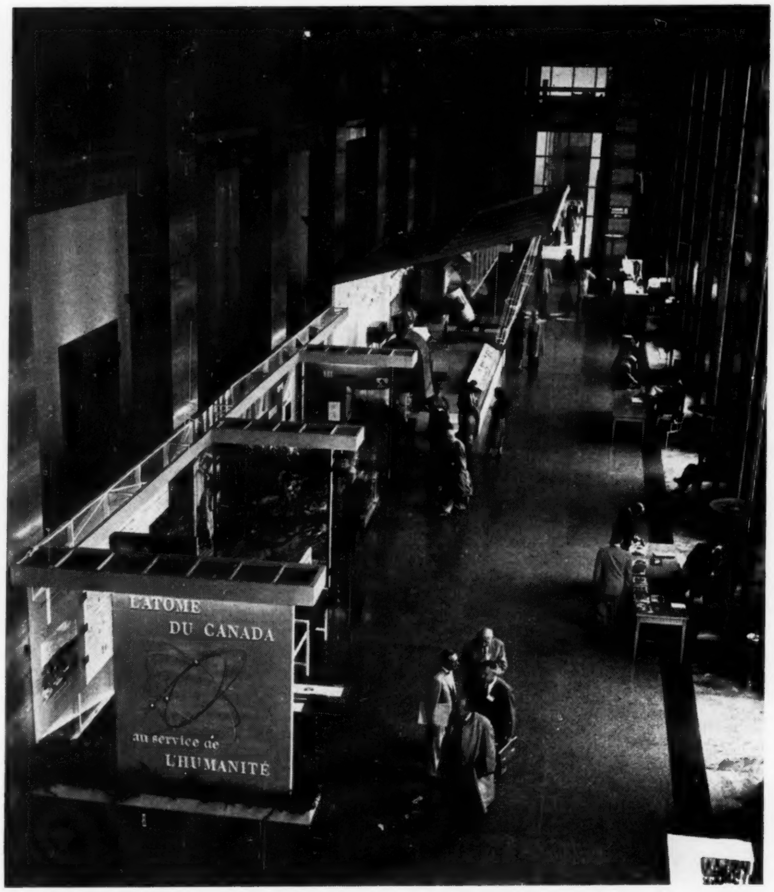
. . . Atoms for Peace Conference

USSR Radiograph. A group of American visitors look at a radiograph for studying the circulation of the blood—part of the display of the Soviet Union. (*UN photo.*)

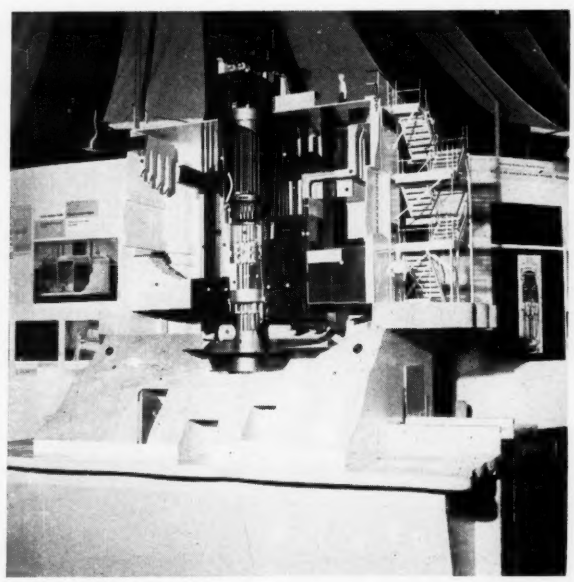


Canadian NRX Reactor. Shown *above* is a model of the NRX reactor which is part of the Canadian display. This reactor is still under construction in Canada. (*UN photo.*)

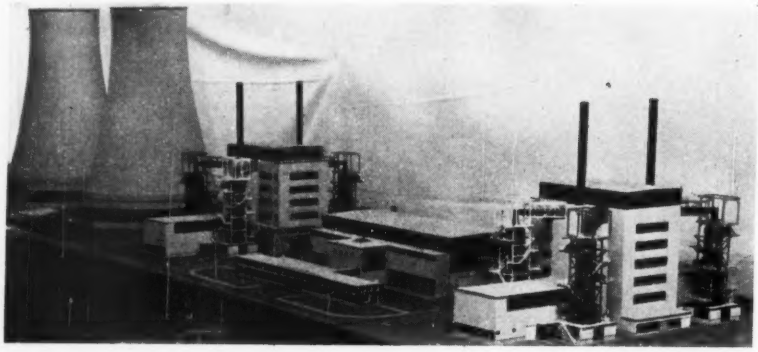
Canadian Display. General view of the Canadian display, *right*, in the main lobby of the Palais des Nations Assembly building. (*UN photo.*)



Swiss Reactor. Swiss display at the commercial exhibit—model of a nuclear reactor at Wurenlingen, Switzerland. (*UN photo.*)

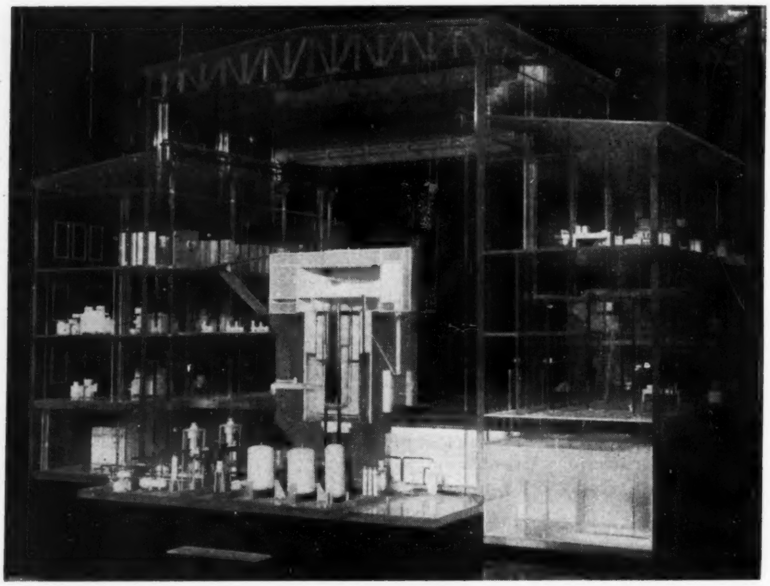


U. S. Materials Testing Reactor. Shown here is a materials testing reactor displayed by the United States. (*UN photo.*)

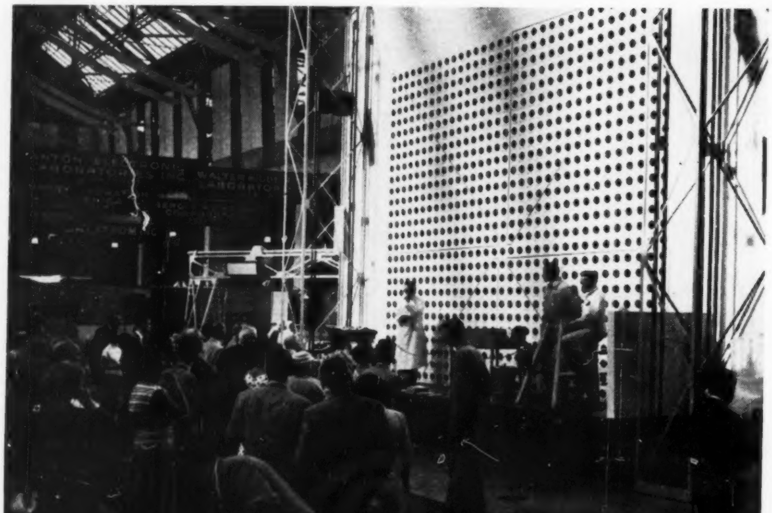


British Calder Hall Reactor. Model of Calder Hall Reactor now under construction (and well advanced) for the United Kingdom Atomic Energy Authority. This model was in the Palais des Exposition. (*U. K. Atomic Energy Authority photo.*)

USSR Reactor. This visitor looks at a model of a nuclear reactor displayed by the USSR. (*UN photo.*)



USSR Heavy-Water Reactor. Shown *above* is a plexiglas model for an experimental heavy-water reactor displayed by the Soviet Union. (*UN photo.*)



U. S. Nuclear Reactor. At *left* is a view of the commercial exhibit, with, in the foreground, an American display—a nuclear reactor similar to the other reactors in operation in Brookhaven, N. Y., and Oak Ridge, Tenn. This reactor was sold to the Swiss Government when the exhibit closed. (*UN photo.*)

Prof. Otto Hahn, German scientist, reading a scientific paper during the conference. *(United Nations photo.)*

Prof. Niels Bohr, Danish scientist, reading a paper on "Collective Motion in Atomic Nuclei." *(United Nations photo.)*

Isidor I. Rabi, United States scientist, one of the six vice-presidents of the conference. *(United Nations photo.)*

exactly ten years since the explosion of the first atomic bomb had made humanity "brutally aware that a brilliant new discovery had been made and a source of energy of extraordinary power created"; and by the reading of messages of greeting from President Eisenhower, Anthony Eden, Edgar Faure, Marshal Bulganin, and Nehru, welcoming the holding of the Conference and the opportunity that it afforded, in the words of President Eisenhower, to "unfold to the peoples of the world the bright promise of the benign atom." Dag Hammarskjold, Secretary-General of the United Nations Organization, also made a brief speech, in which he predicted that, although the Conference was scientific in conception, it would have profound economic, social, and political consequences. It was appropriate, therefore, after this opening theme, which Dr. Bhabah's address so pointedly emphasized, that the Conference should proceed to review the future needs of the world for power, and the possibility of satisfying them.

World Energy Requirements

As a basis, the Conference had before it a survey of "World Energy Requirements in 1975 and 2000," in which, for comparative purposes, an attempt was made to assess, and to illustrate with a flow sheet, the sources of the power produced in 1952 and the manner of its disposal. Taking the fuels used at their full calorific value, it was calculated that the total was equivalent to 29 thousand million megawatt-hours of electricity, mostly obtained from mineral fuels. Only a fraction of this total was actually put to work. Substantial quantities were lost in the generation of electrical power, but the largest losses were at the consumer level. Nearly half of the original total was dissipated as waste heat in the course of using the energy. Losses and diversions together amounted to 65 per cent. Of the total energy consumed, North America took 35.9 per cent, Western Europe 19 per cent, Eastern Europe (USSR) 17.2 per cent, and Asia 13.4 per cent. An investigation of the energy usefully consumed (10.2 thousand million mw-hr electricity equivalent) showed that 8.4 of these units were consumed in developed areas; and, examining in turn the requirements of industry, transport, agriculture, and households, it appeared that these main consumer divisions took, respectively, 5.8, 0.8, 0.3, and 3.3 thousand million mw-hr in 1952. Extrapolating from these figures in the light of the recorded or deduced (and variously weighted) figures from 1860 onward, it was estimated that, in 1975, the world requirements of useful energy would be, for industry, 18; for transport, 2.5; for agriculture, 0.5; and for households, 6, making a total of 27 thousand million mw-hr. By the year 2000, the corresponding figures would be 60, 8, 1, and 15, and total of 84—an increase of more than eight times in less than half a century.

This paper was prepared by the United Nations Organization and included a most valuable bibliography of the sources of statistical and other information. It was followed by three others, which were discussed together, by P. Ailleret (France) on "Estimation of Energy Requirements," E. A. G. Robinson and G. H. Daniel (United Kingdom) on "The World's Needs for a New Source of Energy," and E. S. Mason (United States) on "Energy Requirements and Economic Growth." Broadly speaking, these authors took a more moderate view of the probable increase in demand by the end of the century, putting it at $2^1/_2$ to 3 times the 1952 figure. As Professor Robinson and Dr. Daniel observed, a straight projection of the rates of growth of world industrial output during the past few years could lead to an estimate of an annual growth of more than 4 per cent in the world consumption of energy; but, they ask, was it possible to visualize a world in which average energy consumption per head was 30 times the present figure, and still growing rapidly? That, however, would be the effect of continuing a 4 per cent rate of increase until the year 2050. They thought it wiser to assume that ultimately the demands for energy would be satiable.

The Cost of Nuclear Power

Quite evidently, whichever estimate might be adopted for the rate of increase in world energy demands, only by the large-scale exploitation of nuclear power could such demands be met; and particular interest attached, therefore, to the various papers in which these economic factors were considered. There were two dealing with the question of capital investment, one by J. M. Hill and Major-General S. W. Joslin (United Kingdom), and the other by W. Kenneth Davis (United States). They approached the subject rather differently, but both papers were in substantial agreement that the capital cost per kw generated might be brought down, in a reasonably short

Seen here, *left* to *right*, are: Viktor S. Vavilov (USSR), Deputy Conference Secretary-General; John Gaunt (UK), scientist on the staff of the conference; and J. V. Dunworth, British scientist attending the conference, who was reading a paper on thorium. (*United Nations photo.*)

Francis Perrin, *left*, Head of the French Atomic Energy Commission, one of the six vice-presidents of the Conference, during a meeting of the conference looks over a note shown to him by Jacob A. Goedkoop of the Netherlands, scientist on the staff of the conference. (*United Nations photo.*)

term of years, to a figure comparable with that of a large thermal station. The conclusions of Dr. Hill and General Joslin were that, if a country were prepared to purchase proved reactor designs and to make contracts for the supply and processing of the nuclear fuel, the capital cost of a nuclear power station would vary "from about double that of a conventional station in the very near future down to perhaps 50 per cent above conventional power-station costs within the next decade." Though they did not specifically mention the point, it may be assumed that the cost of conventional stations and of their fuel will continue to rise. Mr. Davis expressed the view that nuclear plants "ultimately will cost no more than conventional power plants," but added that "this is a considerable time off and will probably require the development of improved types of power reactors." J. A. Lane (United States), in his paper on "Economics of Nuclear Power," considered that, in due course, nuclear plants "will produce electricity at prices well below the average for conventional fuels" and that the necessary advances to achieve this result would be accomplished "in the next five to ten years."

USSR First Atomic Power Station

Naturally, great interest was evinced in the paper on "The First Atomic Power Station of the USSR," by D. I. Blokhintsev and N. A. Nikolayev. It has an output of 5000 kw and, it was stated, started generating electricity on June 27, 1954. The station contains a pressurized water-cooled uranium-graphite reactor with a rated heat-generating capacity of 30,000 kw, and uses as fuel 550 kg of enriched uranium containing 5 per cent of U235. The heat-transfer system consists of two circuits. The water in the first circuit, which circulates through the reactor, is under a pressure of 100 atm and gives up its heat, through heat exchangers, to the water of the second circuit, which is transformed into steam to drive the 5000-kw turbogenerator. A practical difficulty encountered was that repeated heating and cooling, over the range from 20 to 500 C, caused "substantial changes" in the dimensions of the uranium rods. The reactor is enclosed in a cylindrical steel casing, set on a concrete foundation and filled with graphite brickwork. To avoid burning the graphite, an atmosphere of helium or nitrogen is maintained in the casing. A total of 128 "fuel channels" penetrate the graphite, each comprising a long graphite cylinder containing thin-walled steel tubes carrying the water of the primary circuit. The water passes down the tubes and returns upward over the surface of the uranium fuel elements. Since the plant was started on June 27, 1954, it was stated, it had produced about 15 million kwhr of electrical energy.

The Dounreay Fast Reactor

There were, of course, numerous papers dealing with various types of reactors, actual or projected, and it is not practical to summarize the whole of them. Some had been previously described elsewhere. In view of the general theme of the Conference, however, which was power production rather than pure research, some particulars should be included of the Dounreay fast reactor, now under construction for the United Kingdom Atomic Energy Authority. It is situated in the north of Scotland and was described in a paper by J. W. Kendall and T. M. Fry. The plant will consist of a vessel—the authors referred to it as a "pot"—through which enough coolant can be pumped to remove more than 60 mw of heat, and the arrangement is such that, if the initial design proves unsatisfactory, the contents of the pot can be removed and replaced by a new assembly. The desired high heat output postulated a coolant of high specific heat and thermal conductivity, and preferably a low vapor pressure. These considerations led to the choice of liquid sodium, perhaps with the addition of potassium to lower the freezing point. The core of the reactor is so highly rated that adequate cooling must be assured at all times; the

core would quickly rise to melting point if the flow of coolant ceased. For this reason the cooling circuit will be of stainless steel, butt-welded throughout, and with every weld radiographically inspected. There are no valves in the circuit. The primary circuit will comprise 24 parallel loops, each having two separate heat-exchanger sections and an electromagnetic pump. The lower part of each loop will be jacketed with an outer tube through which the secondary coolant (sodium or sodium-potassium alloy) will be pumped. Multiple secondary and subsequent heat-rejection circuits will be provided, and even their power supplies, provided by diesel-driven generators, will be separated, each generator being connected to only two of the primary pumps; the failure of a generator will only cut out one tenth of the pumps.

The secondary coolant will carry the heat to a boiler-house for steam-raising; therefore it must not be allowed to become radioactive, so a neutron shield of borated graphite will be inserted between the pot and the heat exchangers. The graphite and the pot will be supported on a steel structure standing on a concrete base, forming part of the biological shielding. This base will consist of a concrete bowl almost 90 ft in outside diam and 45 ft high, with a minimum thickness of 5 ft. The roof slab will be supported on a ring of vertical columns. The reactor will be enclosed in a steel sphere 135 ft in diam and about 1 in. thick. The designers believe that, by suitable controls, it will be possible to eliminate all risk of an explosion, should the reactor "run away" and consequently explode; for it is accepted that no pressure vessel of practicable dimensions could contain such an explosion, the effects of which would be disastrous over a very wide area. Precautionary calculations were made regarding the risk that the sphere might collapse in the event of a breakdown, but these indicated that the stress in the steel could not exceed 1 ton per sq in., even in the most unfavorable combination of circumstances. Although the consequences of failure of any essential part of such a plant are so serious, the authors venture to hope that, "when experience in fast reactors has been gained, they will prove a safe and enduring source of power for mankind."

The Prospect for the Future

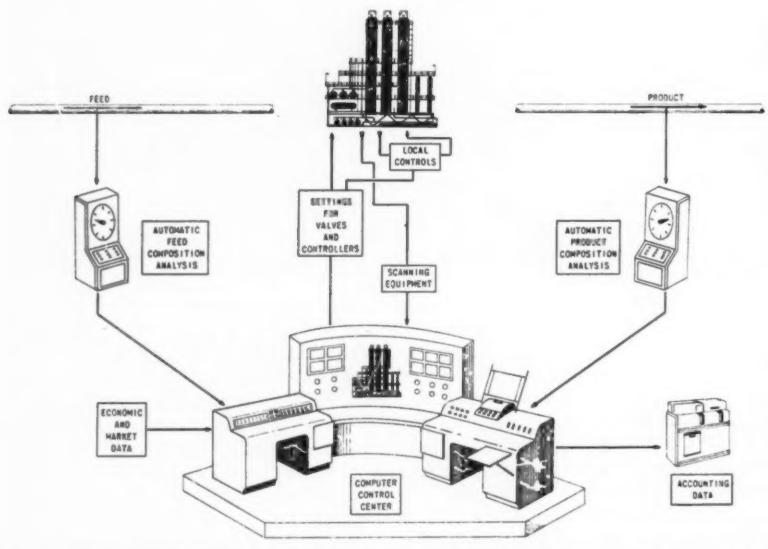
The age of nuclear power has definitely arrived; though, as the design problems of Dounreay have indicated, with a host of new risks attached, as well as the promise of untold benefits. Yet, it appeared, from the discourses of some of the experts, that many of the risks might prove to be much less serious than had been feared. After all, the risks attendant upon going to sea in a steamship are much less today than they were 120 years ago, solely as the result of experience, and careful design and manufacture. Whether it is wise, at this stage or for some time to come, to encourage nations with only limited acquaintance with the higher technologies to invest in power-producing reactors, is a debatable point—unless the necessary staff, as well as the fission material, are to be provided as part of the contract; a point which the Russians will certainly have to consider with some care, when they proceed with their declared program of aiding underdeveloped countries to enjoy the benefits of atomic energy. As was remarked, however, in the course of the Conference, the march of science cannot be put into reverse. Sir John Cockcroft, in the evening lecture which he delivered during the Conference, told his audience that "power from fission reactions is assured." He had been asked repeatedly in a press conference whether what his questioner called "H-bomb power" was a likely prospect, but refused to be drawn. In his lecture he was more specific: "I would like," he said, "to have been able to predict when the exciting prospect of power from fusion reactions would be achieved but, although we are working seriously on this problem in Britain, my vision is not good enough for that." He had no doubt, however, that it would be achieved, and "long before it is essential for man's needs."

Prof. D. I. Blokhintsev, scientist from the Soviet Union, reading a paper during the Conference which described Russia's first atomic power station. The reactor has an output of 5000 kw and has been in operation since June 27, 1954. *(UN photo.)*

Sir John Cockcroft, *left*, Chairman of the United Kingdom Atomic Energy Authority, one of the six vice-presidents of the Conference, and Frederic de Hoffmann, United States scientist, on the staff of the conference. *(United Nations photo.)*

ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings



In a petroleum plant of the future industry will be able to formulate a processing schedule based on market prices and requirements. Bring the plant on stream and turn it over to the computer controller, which will continually analyze feedstocks, products, and operating data. It will make corrections to keep the plant on schedule, and simultaneously handle accounting information until all requirements are met.

Petroleum Mechanical Engineering

Future Trends in Automation, by G. G. Gallagher and R. A. Robinson, The Fluor Corporation, Ltd., Los Angeles, Calif. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-5** (multilithographed; available to July 1, 1956).

Automation in petroleum refining can be divided into two basic problems:

1 Work operation: Where changes are made to feedstocks.

2 Transfer operations: Where feedstocks are transported and positioned for the work operations to be performed.

It is the ease with which these transfer operations are accomplished that gives petroleum processing a big advantage over other industries.

Because of the fluid nature of the materials handled, and other inherent features compatible to automation, this industry is found in front, with the closest present-day approach to a completely automatic factory.

It is within the scope of present-day instrumentation to design a refinery which would start up and shut down at the push of a button, repair itself to a limited extent, and otherwise meet minor emergencies. In between these utility functions the plant could be made to operate itself automatically and efficiently with regard to the economic processing of feedstocks to meet market demands.

The future trend to automatic data-handling and data-reduction equipment is firmly established. At the present time there are approximately five operating refinery installations of automatic logging equipment and four known to be in the planning stage. These data-handling machines not only print the hourly log sheet in a matter of minutes, but may be equipped with scanning mechanisms to watch over critical points between logging periods.

Product analysis is the logical basis for control in the campaign to raise the level of operating efficiency and quality of product. These analyzers must be continuous and capable of transmitting an acceptable signal to data-handling equipment.

Improving existing equipment is a continuing trend. It follows many blind alleys and is guilty of being sidetracked by fads. To be consistent with the goal of an automatic plant, existing methods and equipment must be improved.

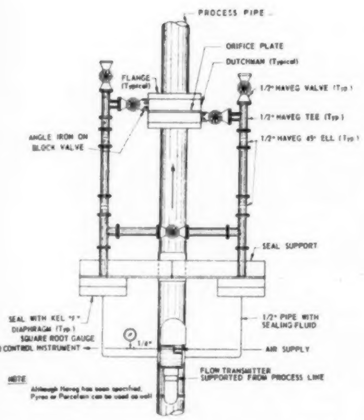
Improved process efficiency demands improved control circuits. One of the factors in reducing off-spec and rerun time is the control-circuit response time. Plants are becoming physically larger. To comply with these demands a trend has been established away from pneumatic controls, with their physical limitations, to electronic mechanisms with instantaneous electronic transmission of data.

This trend has important relationships with the other trends of automatic data-handling, continuous stream analysis, and computer control. Fundamentally, all of these new developments are electronic devices and for a satisfactory marriage of all of them at some future time it is essential that they be compatible.

As is naturally the case with new developments, tools are available before we are capable of using them fully, or comprehending their full advantages. When experience is gained with these two new tools, data-handling equipment and continuous stream analyzers, the benefits to be gained from a computer-type master controller will become more evident.

Developments in Instrumentation by the Petrochemical Industry, by R. G. Marvin, W. L. Stuart, G. W. Lunsford, Mem. ASME, and E. E. Ludwig, The Dow Chemical Company, Freeport, Texas. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-4** (multilithographed; available to July 1, 1956).

Electrical, electronic, and pneumatic instruments find many applications in the petrochemical industry. Rapid growth of this industry has created a program of instrument design and development by many petrochemical companies. They have also co-operated completely with the instrument manufacturers in these developments as well as in testing programs.



Standard force balance-type small-displacement meter sealed to prevent corrosive liquid from coming in contact with the meter. There are two seals with diaphragms of suitable corrosion-resistant material.

This paper presents a few selected examples of instrument development. These examples put emphasis on the interest of the petrochemical industry in applying the latest developments and best techniques for the instrumentation of commercial processes.

The paper discusses automatic computers in the petrochemical industry, relative flow measurement at high pressure, ratio flow control of two gas streams in a process, use of strain cell for pressure control, control of an absorption refrigeration system, use of a sealed differential-type meter, and flow measurements of high-pressure gas streams impeller-type flow-sensing cell.

Fluid-Coker Mechanical-Design Aspects, by R. H. Maas, Esso Research & Engineering Company, Linden, N. J., and E. J. Newchurch, Esso Standard Oil Company, Baton Rouge, La. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-6** (multilithographed; available to July 1, 1956).

There has been a growing need in the petroleum industry in recent years for a better means of converting residual oils into distillate products. As a new answer to this problem, the Esso Research and Engineering Company (formerly Standard Oil Development Company) announced the "fluid-coking" process in August, 1953.

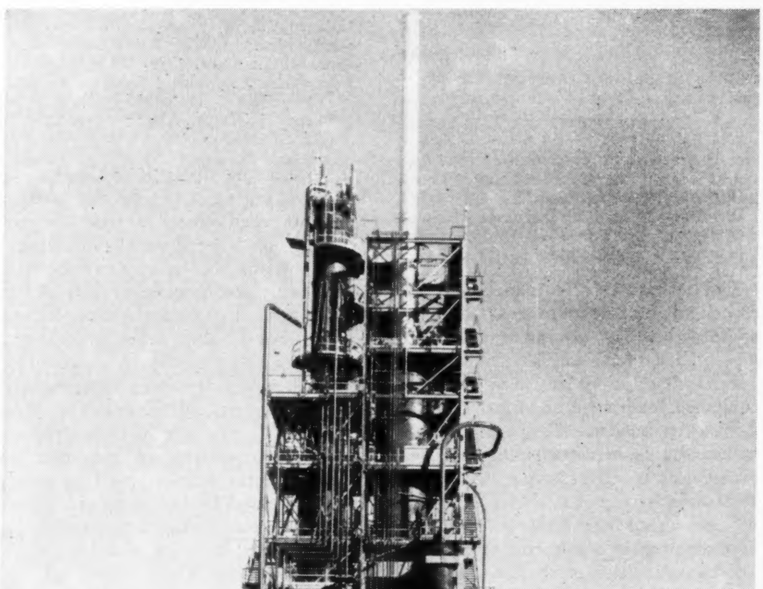
This paper discusses the mechanical-design aspects of the fluid coker.

Fluid coking is a simple rugged continuous-coking process. The fluid-coking process employs no catalyst. It depends on the heat and surface area provided by a circulating stream of finely divided coke particles.

The apparatus is quite similar to a fluid catalytic-cracking unit. It consists of a reactor or coking vessel in which the feed is converted into dry gas, naphtha, gas oil, and small coke particles, and a burner vessel where a part of the circulating coke is burned to supply heat for reaction. The reactor and burner vessels contain fluidized beds of finely divided particles of coke at temperatures of about 950 F and 1125 F, respectively. The vessel top pressures are in the order of 5 to 10 psig.

Fluid coking can successfully handle the lowest quality and the shortest residua produced by modern vacuum distillation, and also the very poorest grades of petroleum residua, including asphalts and thermal-cracking-coal tars. Longer atmospheric bottoms can also be handled. Excellent liquid yields are obtained from these various feeds with a minimum of by-product gas and coke.

The gas-oil product is a satisfactory catalytic-cracking feedstock. The gasoline produced is generally of 75 to 80 octane number and can be treated to make a satisfactory gasoline blending component. The gases are highly unsaturated and are useful in polymerization and alkylation reactions. The fluid-coke product is unique and interesting. It is clean and dustless. It can be easily handled as a "fluid" and it can be transported readily by a number of standard techniques. The coke is expected to find its way into the already established market for petroleum coke: for example, electrodes for aluminum production, various metallurgical and specialty uses, and combustion in different kinds of boiler furnaces.



The first commercial fluid-coking unit went on stream in December, 1954, at the Billings, Montana, refinery of the Carter Oil Company. The plant is a 3800-bbl per day unit.

Orthoforming—An Application of the Fluid-Solids Technique to Catalytic Reforming, by M. R. Smith, The M. W. Kellogg Company, New York, N. Y. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-7** (multilithographed; available to July 1, 1956).

The evolution of catalytic reforming design—with a molybdena catalyst which can be regenerated continuously—has progressed from the first fixed-bed cyclic designs introduced in 1940 through several "side-by-side" fluid-catalyst-vessel arrangements to the orthoflow-type design. It is this purely mechanical improvement that has prompted the trade name "Orthoforming."

No basic yield or activity enhancements are presently claimed for orthoforming over the side-by-side vessel arrangements. Its advantages lie rather in ease and cost of construction, simplification of operation, better control of catalyst flow, better heat conservation, improved stripping arrangements, and absence of external catalyst lines which might conceivably lead to difficulties by eroding or burning through.

Fire-Protection Equipment for Pipe Lines and Terminals, by A. Lee Dunlop, Tulane University, New Orleans, La. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-13** (multilithographed; available to July 1, 1956).

The necessity for an analytical approach to the purpose, extent, and type of fire-protection equipment used for pipe lines and terminals is outlined.

Brief descriptions of some available equipment and their historical development are presented. The paper discusses specifically foam systems, fog systems, extinguishment by cooling, and alarms and controls.

Selection of the type of equipment depends largely upon the hazards involved, and also on the basic purpose for which it is provided and the degree of protection desired. Fire-protection equipment of pipe lines and terminals, as here conceived, includes all designs, devices, and equipment which consciously contribute to the prevention of fires or to their control and extinguishment.

Some Cases of Stress Due to Temperature Gradient, by D. J. Bergman, Mem. ASME, Universal Oil Products Company, Des Plaines, Ill. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-12** (multilithographed; available to July 1, 1956).

In dealing with the problem of stress due to temperature gradient the cause of stress must be considered, and whether the stress remains constant, decreases or increases as yield or creep occurs as a result of high stress.

A quantitative analysis of the stress due to a maintained temperature differential in a flat bar is given for both free and restrained bar, and a comparison with the cases of a flat plate and a thick pipe.

Practical cases are reviewed, including a pipe heated from the inside, heater tubes with internal pressure and high heat inputs, stresses set up by localized heating when welding a corrosion liner in a vessel, differential expansion due to noncompatible welds, vapor barriers through an insulation wall, and the temperature-transition skirt for hot vessels.

Thermal Cycling Test of a Hot Spot on a Vessel, by P. N. Randall, Standard Oil Company (Indiana), Chicago, Ill., and H. A. Lang, Mem. ASME, Rand Corporation, Santa Monica, Calif. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-2** (multilithographed; to be published in Trans. ASME; available to July 1, 1956).

Regenerator shells of fluidized catalytic-cracking units can develop surface hot spots when erosive catalyst destroys portions of the internal insulation. Since bursting of the regenerator shell could easily result in heavy loss of life and property, it is natural that operators are inclined to shut down a unit and make repairs as promptly as possible, although such a shutdown may seriously reduce the output of the refinery. It is desirable to evaluate the hazards of continued operation where thermal cycling exists, since fluctuating stress states produced by hot spots can be expected to recur in other refinery units.

This paper presents the results of laboratory tests which simulated the effect of repeated cycles of heating and cooling of a spot on a catalytic-cracker regenerator shell.

A specimen was made to resemble in all feasible respects a 6-ft-sq piece of a cylindrical shell of a regenerator, including welded seams and vapor stops. After 50 cycles of heating to 900 F at the center of the spot for one or two days, then cooling to near room temperature the plate was radiographed, its microstructure examined, and its mechanical properties determined.

No evidence of cracking or of deterioration of the metallic structure was observed. Some distortion was produced by the first few cycles of heating, but continued cycling did not produce further distortion.

Control of Pulsations in Piping Systems, by C. Newman, The Fluor Corporation, Ltd., Los Angeles, Calif., and N. H. Moerke, The Fluor Corporation, Ltd., Paola, Kan. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-8** (multilithographed; available to July 1, 1956).

The magnitudes of gas-pulsation problems are difficult to predict before a compressor plant is placed in operation. In many cases, otherwise well-designed plants have received unfavorable criticism from operators and management because of operating difficulties caused by the presence of excessive gas pulsations under actual operating conditions. However, through the diligent use of dynamic relationships in the design of compressor-plant piping and pulsation-dampening equipment, the problems attributed to gas pulsations can be minimized.

There are two basic ways of controlling these gas pulsations:

1 Resistive. Methods whose efficiency is a function of pressure drop and which consist of a reduction in area of the flow path by means such as orifice plates and valves.

2 Reactive. Methods whose efficiency is a function of frequency and which consist of properly designed changes in pipe sections and internals such as low or high-pass dampeners.

The paper discusses these various methods of controlling pulsative waves and reviews the pulsation-frequency-response characteristics of each type of equipment.

In addition, the paper presents general answers to the question "How much control of pulsation or what degree of damping is required to prevent piping vibration or orifice metering error?"

A Pressure-Drop Correlation for Turbulent Two-Phase Flow of Gas-Liquid Mixtures in Horizontal Pipes, by J. M. Chenoweth and M. W. Martin, C. F. Braun & Company, Alhambra, Calif. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-9** (multilithographed; available to July 1, 1956).

This paper reports a study of pressure drop for the flow of two-phase mixtures of air and water in $1^1/_2$-in. and 3-in. pipes.

A total of 264 runs is presented for test conditions including pressures to 100 psia, liquid rates to 200 gpm, and air rates to 700 scfm.

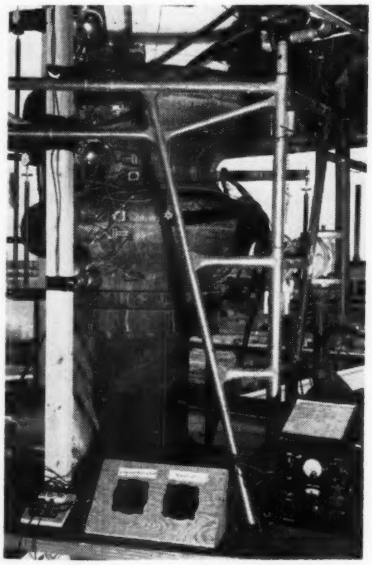
The data agree closely with values predicted by the Lockhart and Martinelli correlation for conditions near atmospheric pressure. But at 100 psia, the Lockhart-Martinelli correlation predicts values as much as 2.5 times higher than those measured in 3-in. pipe.

The authors have developed a new empirical correlation for turbulent two-phase flow. The new correlation satisfactorily handles both the results of this study and the results of many other investigations. Pressure drops predicted for 506 test conditions show an average deviation from measured values of plus or minus 20 per cent.

High-Pressure Expansion-Joint Studies, by S. R. Kleppe, Esso Research & Engineering Company, Linden, N. J. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-10** (multilithographed; available to July 1, 1956).

The first need for a high-pressure expansion joint in a process unit was encountered by the Esso Research and Engineering Company in the design of the vapor heat exchanger of the fluid hydroformer. Past failures due to stress-corrosion cracking of thin-walled, low-pressure expansion joints prompted rejection of the best commercial high-pressure joint, namely, the torus type. This is because this shape joint presently can only be fabricated to a maximum thickness of 0.078 in.

For this installation a thick-walled semitorus expansion joint was employed, for which an experimental stress analysis was made to establish movement and pressure-design limits. These data were then correlated with theory and a general design formula was established.



Semitorus joint in vapor heat exchanger at Baton Rouge Refinery, Esso Standard Oil Company. Strain measurements were taken with the use of SR-4 strain gages mounted on the bellows of this joint.

Yield and Bursting Characteristics of Heavy-Wall Cylinders, by J. H. Faupel, Mem. ASME, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-1** (in type; to be published in Trans. ASME).

During the past seven years, nearly 100 heavy-wall cylinders have been tested to bursting at the Engineering Research Laboratory of the author's company.

The heavy-wall cylinders were constructed of plain-carbon steel, various low-alloy steels, various stainless steels, and aluminum bronze. Materials covered a range of mechanical properties as follows: Ultimate strength, 66,000 to 188,000 psi; transverse ductility (elongation in 1 in.), 4 to 66 per cent; and longitudinal ductility (elongation in 2 in.), 12 to 83 per cent.

As a result of the work, formulas have been developed which predict elastic-breakdown pressure and bursting pressure for static loading. These predictions are based on a mathematical theory which uses the results of tensile tests made on small specimens of the cylinder material.

For the most part, the new design formulas developed are corrected or modified versions of previously existing equations. Thus the basic theories have only been modified to meet the requirements of commercial materials.

The work reported deals primarily with the yield and bursting characteristics of monobloc, initially stress-free heavy-wall cylinders in the temperature range 75 to 660 F.

The formulas are reliable within ± 15 per cent of the observed value on a 90 per cent certainty basis.

Batching Natural Gasoline Through Crude-Oil Lines, by C. N. Adams, Phillips Pipe Line Company, Odessa, Texas. 1955 ASME Petroleum Mechanical Engineering paper No. **55—PET-14** (multilithographed; available to July 1, 1956).

Movement of natural gasoline in batches through crude-oil pipe-line systems often results in considerable loss to the shipper because a large portion of each shipment loses its original identity because of contamination and must be reprocessed. Since this reprocessing is an additional cost, the reduction of contamination and resulting product degradation is a highly desirable goal.

Batch shipments of natural gasoline through a common-carrier crude line in Oklahoma were begun in 1951. Shipments originated at the tank farm of a gasoline plant and were delivered to a crude-oil terminal more than 100 miles away. Product mixing was so great during the first batch shipment that it was necessary to reprocess all of the gasoline.

Initial shipments consisting of 25,000 to 50,000-bbl slugs of natural gasoline were pumped into the crude line without any special internal-cleaning program or use of any separating medium at the interfaces. The greater part of each shipment was discolored by crude oil in solution and foreign material in suspension.

In an effort to reduce the percentage of each batch received as contaminated natural gas requiring reprocessing, a series of studies were begun. The primary objectives were to maintain Saybolt Color and ASTM Gum Content at destination equal to that at origin point.

By discovering the various factors causing contamination and finding the means by which they could be eliminated successfully, it has been shown how the volume of product necessary to reprocess was decreased from 70 to less than 3 per cent.

Tennessee Gas Transmission Company Proves Process for Low-Temperature Gasoline Extraction, by R. V. Mertz, PetroTex Chemical Corporation, Houston, Tex. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-19** (multilithographed; available to July 1, 1956).

The largest gas capacity ever designed for a plant processing natural gas was put into operation by Tennessee Gas Transmission Company near Greensburg, Ky., in late 1951. Initial capacity was 750 million cu ft of pipe-line gas per day. In April, 1954, the capacity was further increased to 950 million cu ft per day.

Under normal operating conditions the entire gas stream through the plant is chilled to minus 105 F. Liquids previously found to be objectionable to Tennessee's gas customers are condensed and delivered to a chemical company which converts them to ethane, LPG, and natural gasoline.

Total liquid production is around 440,000 gal daily with a maximum of 475,000 gal in one day.

A unique heat-exchanger arrangement is used in order to accommodate the large volume of gas processed. The gas stream from the pipe line is split into five parallel streams through the plant. Heat exchangers, 42 in. in diam, are assembled end to end to form the five heat-ex-

changer trains. The long exchanger-train arrangement was chosen to simplify the piping and to provide a straight-through path for the gas. This arrangement makes for low pressure drop in addition to the simplified piping arrangement.

Construction of the plant was started in May, 1950. The site near Greensburg, Ky., was chosen because of the convenience to Tennessee's main transmission line and the chemical plant which will process the extracted liquid stream. Tennessee's extraction plant is connected with the chemical plant by a 60-mile long, 8-in. pipe line.

Progress of Turbodrill Development in California, by W. R. Postlewaite, Standard Oil Company of California, San Francisco, Calif. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-16** (multilithographed; available to July 1, 1956).

Advantages of drilling wells with a mud-operated turbine and bit mounted directly on the bottom end of a stationary drill pipe have for years attracted oil producers in this country and abroad.

This progress report reviews the reasons for undertaking the turbodrill development in California, and presents performance characteristics of the multistage turbine operating on heavy drilling fluid.

Design progress which has improved its operation is reviewed, along with changes deserving further attention to increase its durability and usefulness.

A down-hole electric-speed indicator, driven by the turbine, is also described by the author.

Control of Refinery Maintenance and Construction Costs, by E. C. Newton and M. A. Conetta, The Atlantic Refining Company, Philadelphia, Pa. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-11** (multilithographed; available to July 1, 1956).

In 1950 a program was begun with the ultimate purpose of setting up a system for manning jobs in the most adequate yet most economical way possible. From its inception this program progressed along several essential lines, namely, standardization of work methods for all major mechanical crafts, training of supervisors and craftsmen in these techniques, development of related engineered planning times, improvement in the planning and scheduling organization and system, and packing of larger elements of repetitive work including unit turnarounds.

While work methods were being standardized and engineered planning times established, the planning and scheduling organization was tailored to make the the most effective use of such data in planning and scheduling maintenance and construction work. The present organization is staffed to perform the following activities:

1 To develop and plan routine maintenance jobs in the various plant zones.

2 To develop, plan, and follow up all unit turnarounds.

3 To develop, plan, and follow up all authorization work. (These authorizations include construction work and larger elements of nonrepetitive maintenance work).

4 To maintain work control through compiling information and scheduling manpower.

Radiographic Inspection of Lead Linings by W. Skiba and V. P. Bracken, Esso Standard Oil Company, Linden, N. J. 1955 ASME Petroleum Mechanical Engineering Conference paper No. **55—PET-15** (multilithographed; available to July 1, 1956).

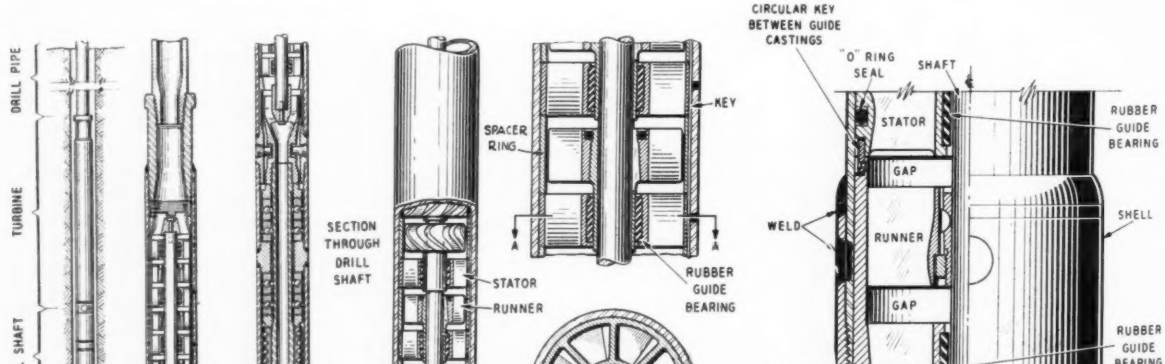
Lead-lined vessels for corrosive service have been inspected for lead defects by an acid-etch technique. Only open surface defects are located by this method.

This paper describes a method developed, and successfully used, to delineate surface and subsurface defects by radiographic techniques. It is a more sensitive and positive inspection method which, when applied, can result in reduced future maintenance costs.

Equipment which is presently in service and contains secondary linings can be inspected with a minimum of trouble by utilizing radiographs.

This technique can be used for quality control during the fabrication of lead-lined equipment. Spot checks would be made to determine if correct procedures are being followed by the fabricator.

Use of this technique for inspection of



Elements of the multistage turbodrill. (*a*) Assembly and sections through multistage turbodrill; (*b*) views of turbine runners, stators, and rubber guide bearings; (*c*) detail of 5-in. turbo with O-ring seals and disk keys between stator stages.

lead-line pipe, valves, and special equipment is possible.

Oil and Gas Power

A Free-Piston Propulsion Plant for a Liberty Ship, by John H. McMullen, Mem. ASME, Maritime Administration, Washington, D. C. 1955 Oil and Gas Power Conference paper No. **55—OGP-14** (multilithographed; available to April 1, 1956).

The Office of Ship Construction and Repair in the Maritime Administration is conducting experimental work known as the Liberty Ship Conversion and Engine Improvement Program. This paper covers the engine-improvement phase of the program as it pertains to the free-piston gas generator-turbine propulsion plant. The paper describes the installation to be made in the ship.

The installation as described will be the first actual free-piston gas generator-turbine installation in the United States, and it is believed will also represent the largest marine application made to date anywhere in the world. The free-piston type was given consideration because of its basic advantages of combining high thermal efficiency with the flexible take-off power characteristics of a turbine drive, and at the same time its possibility of reducing costs. The Office of Ship Construction and Repair believes that a successful free-piston gas generator-turbine propulsion plant may be suitable in the horsepower range from approximately 3000 to 10,000 shaft hp. This will cover the range where diesel engines are considered, and also where steam plants are presently installed, with their inherent disadvantages of reduced efficiency and higher costs for the lower horsepowers. The horsepower range for the installation of free-piston units depends to a great extent on the sizes of gas generators which are ultimately developed. The 3000 to 10,000 shaft hp range is based on the GS-34 gas generator which has a shaft hp rating of 1000.

There are indications that the free piston will also prove to have a good reliability, low specific weight, minimum amount of maintenance, and at the same time lend itself to mass production, which in turn will result in greatly reduced costs. There is no practical reason why the same type of gas generator could not be used in a variety of applications; for example, as a marine propulsion plant, a gas pipe-line pumping unit, an electric generating plant, and a locomotive prime mover.

The plant consists of a number of generators discharging through one or more gas turbines which transmit power through a reduction gear to a propeller. The operation consists of gas generators, producing moderate pressure and moderate-temperature gas which is used to drive the turbine. The gas generator has two opposed pistons in a single power cylinder. These pistons compress their own air for scavenging and charging their power cylinders. They also store the energy required to halt their outward movement and return them for their next combustion stroke. Combustion proceeds on the two-stroke diesel cycle and the power is produced by the exhaust gases and the air driving the turbine.

Safety

Designing the Safer Factory, by R. T. Van Ness, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. 1955 ASME Semi-Annual Meeting paper No. **55—SA-31** (multilithographed; available to April 1, 1956).

Design personnel should be trained so that they will apply the same engineering and analytical approach to safety that they apply to any other problem in engineering.

This paper suggests certain approaches to the safety training of engineers and designers so that they can be relied upon to recognize potential hazards in all of their design work.

The designer must be taught to balance the factor of safety with those of economy and quality. His interest and concern must be constantly stimulated by training and instructions.

Safety considerations and analysis must go beyond the design and specification of the actual facility. In designing facilities which are safe for operation the designer must consider the hazards involved in the construction and maintenance of the facility.

Fuels Technology

The Need and the Opportunities for Fuel Techniques in the Coal Industry, by T. S. Spicer, Mem. ASME, Pennsylvania State University, University Park, Pa. 1955 ASME Joint Fuels Conference paper No. **55—FU-2** (multilithographed; available to August 1, 1956).

This paper attempts to answer the question, "What does the future of the coal industry have to offer the young engineer or technologist?"

It defines the field of fuel technology and its range from fuel engineering to fuel chemistry. It discusses the broad coal industry encompassing production, preparation, processing, and utilization, as well as allied industries.

The magnitude of the industry, the supply and demand of technologists, and their training are also discussed.

The author concludes that opportunities are excellent but the real problem is to attract young people into fuel technology, and fuel technologists into the coal industry.

Production Engineering

Chatter Vibration of Lathe Tools, by S. Doi and S. Kato, Nagoya University, Nagoya, Japan. 1955 ASME Semi-Annual Meeting paper No. **55—SA-22** (multilithographed; to be published in Trans. ASME; available to April 1, 1956).

This paper deals with a chatter vibration which occurs frequently when metals are being machined.

It has been ascertained experimentally that the chatter is a self-excited vibration caused by the lag in fluctuation taking place in the horizontal cutting force behind the horizontal vibration of the work. Because of this delay in cutting force, it has been proved that the chatter may be expressed in terms of a difference-differential equation.

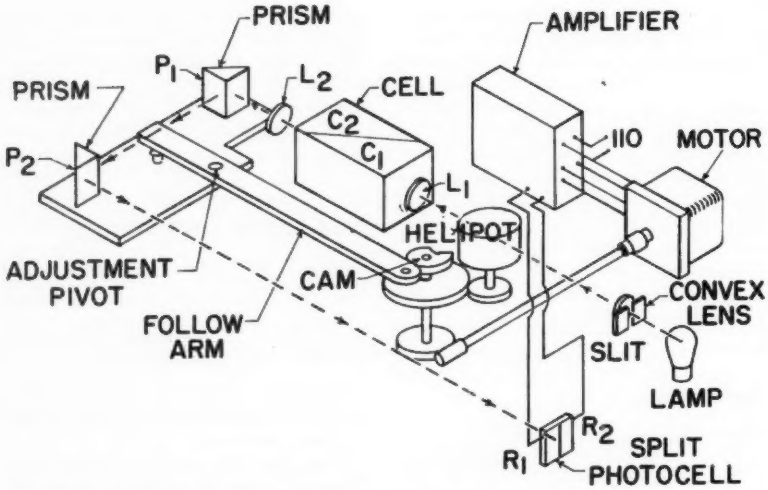
Instruments and Regulators

The Differential Refractometer for Automatic Control of Fractionating Columns, by O. D. Larrison, F. W. Purl, and H. R. Harris, Phillips Petroleum Company, Phillips, Texas. 1955 ASME Instruments and Regulators Conference paper No. **55—IRD-11** (multilithographed; available to July 1, 1956).

Used as an automatic, continuous analyzer, monitor-controller-type instrument, Phillips Petroleum Company's differential refractometer has conclusively demonstrated its ability to control fractionating processes. It has lent itself to use on hydrocarbon mixtures from pentanes to nonanes inclusive, and on any fractionating column where there is a minimum difference of .00001 refractive index unit from tray to tray in the sampling area of the column. From this point, a continuous sample through the instrument is analyzed for refractive index changes. These changes unbalance a servomechanism which in rebalancing causes corrective action to be applied through a conventional electronic recorder to the process variable.

Successful applications have been: Pentane splitters, hexane splitters, heptane splitters, and many other separations involving both aromatic and aliphatic hydrocarbons. The only apparently inapplicable process was a depentanizer involving considerable cyclopentane in the overhead product.

Maintenance is largely routine and



Schematic view of differential refractometer. Used as an automatic, continuous analyzer, monitor-controller-type instrument, it has demonstrated its ability to control fractionating processes.

preventive. Operation is simple enough that process operators can easily learn to use it. As with most forms of automation, the big problem is fitting the instrument into the existing control system, because it demands that all the process instrumentation be in good condition.

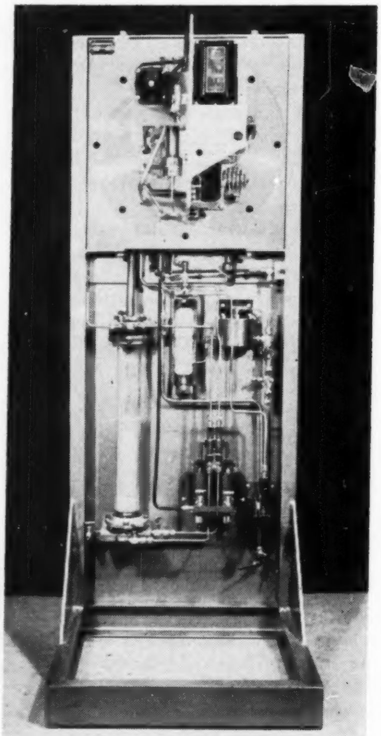
Process Control by End-Point Analysis and Associated Data-Reduction Systems, by S. M. Rock, ElectroData Corporation, and J. Walker, Consolidated Engineering Corporation, Pasadena, Calif. 1955 ASME Instruments and Regulators Conference paper No. **55—IRD-9** (multilithographed; available to July 1, 1956).

At present, few completely automatic control systems are in operation. However, instruments trending in this direction, such as continuous indicators, are on the market. Among such instruments being used for control are conductivity measuring devices, refractometers, pH meters, viscosimeters, and the like.

More complicated instruments, in general, are still used in the batch method. Accessories, both digital and analog, are required to make these instruments useful in control or semicontrol. Some of them utilize programming units or small computers which may be classed as data-reduction devices. Larger digital computers are used in batch analysis of complex streams, thus contributing to knowledge that will be used in design of automatic systems.

Digital computers also are being used in optimum-product programming—a precursor of future control of output in terms of input.

Examples of presently operating instruments are given and present status of the associated data-reduction equipment is discussed.



Latest design in miniature mass spectrometers. This instrument is capable of laboratory batch analyses or continuous stream analysis in the hydrogen through gasoline range. The mass spectrometer is used in medical, refinery, metallurgical, geophysical, and air-pollution fields.

A brief extrapolation into immediately possible trends and later possibilities is also given.

Study of Pneumatic Processes in the Continuous Control of Motion With Compressed Air—II, by J. L. Shearer, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Instruments and Regulators Conference paper No. **55—IRD-10** (multilithographed; available to July 1, 1956).

Results of analytical and experimental work reported in Part I (Paper No. 55—IRD-4) are employed in the analysis of a valve, ram, and mass-load system. This complete servomotor system is analyzed for its response to small changes of valve opening and to changes of external load force. A simple electronic analog of the system is used to study means of providing adequate system damping.

Results indicate that connecting a flow resistance and tank of suitable size to each end of the ram permits a stabilizing transient flow to each of the tanks when the ram pressures are changing rapidly.

Design charts provide means of quickly finding the roots of the third-order characteristic equation for the system with transient-flow stabilization.

Applied Mechanics

A Study of the Speed of Sound in Porous Granular Media, by H. Brandt, California Research Corporation, La Habra, Calif. 1955 ASME West Coast Applied Mechanics Conference paper No. **55—APM-37** (in type; to be published in the *Journal of Applied Mechanics*).

A theory is developed to explain the influence of pressure, porosity, and liquid saturation on the speed of sound through a porous granular medium. An aggregate of randomly stacked spherical particles of four different sizes is used as a model for the porous medium. The volume-pressure relationship of the aggregate is determined by means of the Hertz theory for the deformation of elastic and isotropic spheres in contact. This relationship is extended to embrace the case of liquid saturation of the aggregate. The bulk modulus is derived from the volume-pressure relationship and the speed of sound is determined from the bulk modulus.

It is shown how the theory can be extended to apply to the speed of sound through an aggregate comprised of nonspherical granules and finally, in an approximate form, through a consolidated granular medium.

As an example of the application of the latter the speed of sound through sandstone under various conditions of pressure and saturation is predicted, and agreement is noted between the predicted results and those derived experimentally.

Steady-State Behavior of Systems Provided With Nonlinear Dynamic Vibration Absorbers, by F. R. Arnold, Stanford University, Stanford, Calif. 1955 ASME West Coast Applied Mechanics Conference paper No. **55—APM-30** (in type; to be published in the *Journal of Applied Mechanics*).

This paper stems from investigations of the behavior of nonlinear dynamical systems conducted at Stanford University. Earlier portions of these investigations dealt with the fundamentals of the Ritz averaging method and its application to dynamical systems, of a single degree of freedom, having various types of nonlinearities. Later portions extended the method to multidegree-of-freedom systems and specifically treated systems having two degrees of freedom. The nonlinear dynamic vibration absorber is included in the systems studied.

The response of vibrating systems subjected to sinusoidal excitations and to the action of nonlinear dynamic vibration absorbers is determined by means of a simple procedure. Extensive information including that from more complicated methods of analysis is obtainable.

System behavior is described by means of "response diagrams," and certain peculiarities are discussed.

Elastic Stress Waves Produced by Pressure Loads on a Spherical Shell, by J. H. Huth, Mem. ASME, and J. D. Cole, The Rand Corporation, Santa Monica, Calif. 1955 ASME West Coast Applied Mechanics Conference paper No. **55—APM-31** (in type; to be published in the *Journal of Applied Mechanics*).

A problem of technical interest, which recently has been studied, is the effect of blast waves on the structure of a missile in flight. One such problem is considered in this paper, namely, the calculation of elastic stresses in a thin spherical shell structure resulting from the pressure loading of a blast wave.

The problem is studied with several idealizing assumptions. The blast wave is idealized as a plane wave carrying a pressure jump which moves across the sphere at a constant velocity U. In this respect the motion of the sphere is neglected, as well as the effect of the sphere on the wave. The prediction of the actual pressure distribution is a very complex problem and is put aside.

For analyzing the structure the conventional methods of momentless thin-shell elasticity are adopted.

With these simplifying assumptions the problem is set up and various methods of solution studied. In spite of the idealizations the equations remain complicated owing to the complex nature of the elastic waves and the geometry. For this reason both analytical and numerical methods have been employed to give an over-all picture of the waves and an estimate of the stresses produced.

The Analysis of Dynamic Stresses in Aircraft Structures During Landing as Nonstationary Random Processes, by Y. C. Fung, California Institute of Technology, Pasadena, Calif. 1955 ASME West Coast Applied Mechanics Conference paper No. **55—APM-32** (in type; to be published in the *Journal of Applied Mechanics*).

The basic fact is recognized that throughout the service life of an airplane there occurs a variety of landing conditions and, consequently, it is subjected to transient dynamic loads of varied time histories. Accordingly, a statistical analysis is proposed. The landing-gear impact load is regarded as a nonstationary random process.

In this paper the ensemble means and the correlation functions of landing impacts are defined and their experimental determination from flight or drop tests is illustrated. From these the mean response (displacement, bending moment, shear, or stress), the root-mean-square deviation from the mean, and higher statistical moments are computed.

The results are used to find the most probable maximum stress (at any point in the structure) attained in a given number of landings, or the most probable total number of landings a given aircraft can withstand.

A stress envelope can be derived which represents the distribution of the severest stress in the structure for a large number of landings. A design based on such an envelope, statistically, will have a uniform factor of safety over the entire aircraft with respect to landings.

Perturbation Methods Applied to Nonlinear Dynamics, by Richard Bellman, The Rand Corporation, Santa Monica, Calif. 1955 ASME West Coast Applied Mechanics Conference paper No. **55—APM-33** (in type; to be published in the *Journal of Applied Mechanics*).

The paper presents a simple technique which will in many cases increase the range of effectiveness of perturbation and power-series methods in situations in which the equations treated contain parameters which assume only positive values.

Free Oscillations of Systems Having Quadratic Damping and Arbitrary Restoring Forces, by Karl Klotter, Mem. ASME, Stanford University, Stanford, Calif. 1955 ASME West Coast Applied Mechanics Conference paper No. **55—APM-34** (in type; to be published in the *Journal of Applied Mechanics*).

In this paper, systems are treated which are subjected to quadratic damping forces (of any magnitude) and to restoring forces of any type.

The differential equations of motion for such systems can be transformed into linear differential equations of first order for the velocity squared, whatever the restoring forces may be. A first integral can be obtained readily. From it the exact relationships between any two consecutive maximum displacements ("amplitudes") are derived. These relationships are discussed in detail for various types of restoring forces.

Examples are worked out numerically and illustrated by graphs.

Large Deflection Analysis for a Plate Strip Subjected to Normal Pressure and Heating, by M. L. Williams, California Institute of Technology, Pasadena, Calif. 1955 ASME West Coast Applied Mechanics Conference paper No. **55—APM-35** (in type; to be published in the *Journal of Applied Mechanics*).

Large deflection analysis is carried out to determine the deflections and membrane stresses for an infinite strip when subjected to pressure and temperature variations across the width of the strip with the end points fixed in space.

Results are graphed for both clamped and simply supported edge conditions in the case of uniform temperature T_0 and uniform pressure p_0. The calculations also include the possible thermal-buckling deflections.

Availability List of Unpublished ASME Papers

A number of papers and reports were presented at ASME Meetings which were not preprinted or published. Manuscript copies of these papers are on file for reference purposes in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y. Photostatic copies of these unpublished papers may be secured from the Library at the rate of 40 cents per page. The following papers recently have been placed on file in the Engineering Societies Library:

1955 ASME Spring Meeting

A Study of Crash-Injury Patterns as Related to Two Periods of Vehicular Design, by J. O. Moore
Some Problems Associated With the Design and Operation of Vertical Take-Off Aircraft, by E. W. Geniesse
Chemical Corps Development of Reinforced Plastic Pressure Vessels, by Milton A. Raun
American Acceptance of Heavy Cold-Forming of Steel, by John E. King
Air Mobility for Tactical Units, by C. Henderson
Palletized Shipments, by A. K. Strong
Persuading People, by J. H. Roach

1955 ASME Semi-Annual Meeting

Heat-Cured Resin Adhesives, by C. C. Booth and C. F. MacLagan
Development of a University Reactor Project, by H. J. Gomberg
Measurements of the Contribution of the Electrostatic Component to the Strength of an Adhesive Bond, and Its Use in Quality Control, by S. M. Skinner and J. Gaynor
Some Fundamental Aspects of the Problem of Rubber-Metal Adhesion, by D. M. Alstadt

1955 ASME Management Division Conference

The Professional Status—Unionization Problem, by G. Brooks Earnest

ASME Transactions for September, 1955

The September, 1955, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

Technical Papers

Heat-Transfer Measurements in an Inexpensive Supersonic Wind Tunnel—1, by Joseph Kaye, J. H. Keenan, G. A. Brown, and R. H. Shoulberg.

Heat-Transfer Measurements in an Inexpensive Supersonic Wind Tunnel—2, by Joseph Kaye and G. A. Brown.

The Elastic-Plastic Stress Distribution Within a Wide Curved Bar Subjected to Pure Bending, by Bernard W. Shaffer and Raymond N. House, Jr. (54—A-94)

Stress Distributions in Nonsymmetric Rotating Rays, by P. G. Hodge, Jr. (54—A-96)

Studies on Scabbing of Solids Under Explosive Attack, by K. B. Broberg. (54—A-95)

Buckling of Sandwich Cylinders Under Combined Compression, Torsion, and Bending Loads, by C. T. Wang, R. J. Vaccaro, and D. F. De Santo. (54—A-102)

The Accuracy of Donnell's Equations, by N. J. Hoff. (54—A-105)

Lateral Buckling of Asymmetrical Beams, by H. L. Langhaar. (54—A-99)

The Root Section of a Swept Wing—A Problem of Plane Elasticity, by B. C. Hoskin and J. R. M. Radok. (54—A-97)

Bending of Pretwisted Beams, by J. Zickel. (55—S-2)

Stress Distributions in Orthotropic Strips, by H. D. Conway. (55—S-1)

Vibrations of a Helicopter Rotor-Fuselage System Induced by the Main Rotor Blades in Flight, by M. Morduchow, S. W. Yuan, and H. Reissner. (55—S-7)

Matrix Analysis of Piping Flexibility, by J. E. Brock. (55—S-5)

Inertia Forces in Lubricating Films, by R. S. Brand. (55—SA-1)

Nutation of a Free Gyro Subjected to an Impulse, by B. T. Plymale and R. Goodstein. (55—SA-3)

Shortcomings of Present Methods of Measuring and Simulating Vibration Environments, by C. T. Morrow and R. B. Muchmore. (55—SA-2)

Limits of Economy of Material in Plates, by H. G. Hopkins and W. Prager. (55—APM-2)

The Permanent Deflection of a Plastic Plate Under Blast Loading, by A. J. Wang. (55—APM-1)

The Extended Theory of the Viscous Vibration Damper, by F. M. Lewis. (55—APM-3)

An Approximate Nonuniform Bending Theory and Its Application to the Swept-Plate Problem, by H. J. Plass, Jr. (55—APM-6)

Simplified Formulas for Boundary-Value Problems of the Thin-Walled Circular Cylinder, by Frederick V. Pohle and S. V. Nardo. (55—APM-9)

Forced Vibrations of a Body on an Infinite Elastic Solid, by R. N. Arnold, G. N. Bycroft, and G. B. Warburton. (55—APM-10)

Thermal Stresses in Rectangular Strips—II, by J. S. Born and G. Horvay. (55—APM-4)

On the Kinematic Path of Semi-Trailers, by G. A. G. Frazekas. (55—APM-11)

Combined Tension-Torsion Tests With Fixed Principal Directions, by E. A. Davis. (55—APM-8)

Experiments Concerning the Yield Surface and the Assumption of Linearity in the Plastic Stress-Strain Relations, by P. M. Naghdi, J. C. Rowley, and C. W. Beadle. (55—APM-5)

The Statistical Theory of Size and Shape Effects in Fatigue, by F. A. McClintock. (55—APM-25)

A Criterion for Minimum Scatter in Fatigue Testing, by F. A. McClintock. (55—APM-26)

Brief Notes

Critical Time in Creep Buckling, by J. A. H. Hult.

A Note on Plastic Torsion, by J. H. Huth.

Response Curves for a System With Softening Restoring Force, by H. N. Abramson.

Discussion

On Previously Published Papers by J. T. Kenney, Jr.; I-Ming Feng and H. H. Uhlig; R. W. Bailey; Joseph Kempner; Yi-Yuan Yu; R. H. Long, Jr.; G. D. Galletly; G. Horvay and I. M. Clausen.

Book Reviews

ASME Papers Order Form

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Note: No digests are made of ASME papers published in full or condensed form in other sections of MECHANICAL ENGINEERING.

Copies of all ASME publications are on file in the Engineering Societies Library and are indexed by the Engineering Index, Inc., both at 29 West 39th Street, New York, N. Y.

ASME Transactions and the *Journal of Applied Mechanics* are on file in the main public libraries of large industrial cities and in the technical libraries of engineering colleges having ASME Student Branches.

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Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Human Engineering

Comment by A. K. Simons[1]

The author[2] has described a growing realization among engineers that their machine designs would be more productive if they were easier to operate and maintain. The term "machines" is being used in a broad sense. It is intended to include everything from a thimble to a nuclear reactor.

We are learning that "man" is as much a material part of a machine as steel, oil, and fuel. Man has natural "working stresses" and "fixed capabilities" that must be considered before the machine design is started. Man is adaptable to a certain extent but cannot be molded, shaped, or case-hardened to fit any machine situation. He is the relatively fixed entity in the man-machine combination.

Empirical data and laws of behavior on how people like to receive information from machines and move controls in certain environment is necessary before design engineers can maximize man-machine relationships. The location and design of instruments, warning devices, control designs and control forces, seat design, and such environmental factors as illumination, space, temperature, vibration, and air circulation cannot be evaluated by engineers unless their effect on man is known.

Engineers need "steam tables" and "hardenability charts" for man just as they now use for water and steel, before they can integrate man in their designs scientifically. Our schools should include courses on "man-machine relationships" in every engineering curriculum. Basic laws and data on man's behavior with machines should be included in every engineering handbook. Research and study on man's relation to machines should be encouraged throughout America. This field shows every evidence of touching off a new era of engineering achievement.

Engineers within this Society can take a strong lead in working with anthropologists, psychologists, physiologists, and others to co-ordinate this activity. The American Psychological Association has been trying to initiate some such a co-operative group for over a year. Man-machine relationships concern everyone of the twenty-two Professional Divisions within the Society and the committee proposed by the author can do much to co-ordinate this work.

[1] Chief Engineer, Bostrom Manufacturing Company, Milwaukee, Wis. Assoc. Mem. ASME.

[2] "Proposed Program in Ergonomics," by T. F. Hatch, Mechanical Engineering, May, 1955, vol. 77, pp. 394–395.

Recent References in Human Engineering

1 "Applied Experimental Psychology, (Human Factors in Engineering Design)," by Chapnis, Garner, and Morgan, John Wiley & Sons, New York, N. Y., 1949.

2 "Handbook of Human Engineering Data," second edition, Tufts College, 1952.

3 "Human Body Size and Capabilities in the Design and Operation of Vehicular Equipment," by R. A. McFarland, Harvard School of Public Health, 1953.

4 "Human Factors in Equipment Design," by W. R. Floyd and A. T. Welford, The Ergnomics Research Society, H. K. Lewis and Company, Ltd., 1953 (England).

5 Notes: Human Engineering Institute, Dunlap and Associates, Inc., Stamford, Conn., 1953.

6 "Human Engineering Guide for Equipment Designers," by W. E. Woodson, University of California Press, Berkeley, Los Angeles, Calif., 1954.

7 "Human Factor in the Design of Industrial Machines," by T. F. Hatch, Industrial Hygiene Foundation, Pittsburgh, Pa., 1946.

8 "Human Engineering," by L. E. Abt (Conference Chairman), L. S. Beals, Jr., A. C. Blaschke, J. G. Catranis, H. D. Eberhart, H. Elftman, H. H. Hausner, V. T. Inman, W. E. Kappauf, J. L. Kennedy, L. C. Mead, R. A. McFarland, C. P. Seitz, W. M. Smith, and C. L. Taylor. Annals of the New York Academy of Sciences, vol. 51, art. 7, 1951.

Comment by E. V. Crane[3]

The Secret Ingredient

As engineers, we know that we must seek out the basic rudiments and the applicable laws in order to solve our problems. An organization chart of our present problem might read:

Science—
  Management—
    Human Engineering—
      Ergonomics

[3] Chief Engineer, Canton Division, E. W. Bliss Company, Canton, Ohio. Mem. ASME.

Science was the subject of a recent symposium.[4] Distilled to the essence, the conclusion was: Use your head! Use it honestly!

Management also was subject to recent consideration in the November, 1954, issue of Mechanical Engineering. There again, the same two requisites were basic: Use your head! But *honestly!*

Ergonomics, engineering effectiveness in facilitating men's work, certainly features the same two fundamentals.

Strangely or not, these two basic factors assume distinctive importance in human engineering's study of the human mind.

1 *Using the mind*, as it is regularly considered, refers to the use of the voluntary nervous system, in which one small mental body or brain area is the seat of conscious consideration and decision and the larger outer brain area or mental body occupies a subordinate position in storing the wide variety of learned wisdom, experience, interpretative data, practiced skills, habits of thinking, etc.

2 *Honest* use of the remarkable facilities of the voluntary system utilizes the facilities of the other nervous system which most of us "take for granted." It is the autonomic system *beyond* the conscious. It is the system which furnishes the secret ingredient to success in science, in management, and in ergonomics. We rarely mention "intellectual integrity" because we do take it for granted, even though there are too many cases where we do not find it in others or do not apply it ourselves.

Only recently has the material been available to permit us to recognize that the functions of judgment and organization of thought which are so essential to science, management, and ergonomics are based upon the evaluating facilities of a small inner mental body, the wisdom of which is not learned but is rather instinctive or "God-given."

Just as this essential ingredient of our thinking practices is rarely mentioned in our discussions, so also there is a secret bone of contention which we should get out and examine from time to time. It is the question of the materialistic con-

[4] *The Scientific Monthly*, AAAS, Washington, D. C., September, 1954.

tention of man's supremacy and responsibility to self alone versus religion's contention of man's mutual responsibility to and with some sensed infinite wisdom and power which we call God.

For the purposes of science and management, there is a definite interest in the humble approach of the religious point of view versus the extremes of (*a*) self-centered egotism which acknowledges no higher responsibility, on the one hand, and (*b*) the self which fears responsibility and is identified with the inferiority complex, at the other extreme. In engineering management, we can certainly go along with psychiatry's identification of these two extremes as definite mental diseases which hinder the ergonomic effectiveness of men at work.

As engineers, our interest lies less in the maladjusted problems than in the constructive and creative potentials of our mental equipment. We observe with interest, the similarity of the mind to a compound servomechanism. That is, one in which two small directive centers combine to guide large forces and masses.

The comparison of the subordinate mental functions with business machines, analog computers, and automatic mechanisms, equivalent to self's conscious controls, is appropriate. All of these are subordinate to conscious command in the voluntary system.

The functions beyond the conscious provide the drives of curiosity, initiative, and inspiration. They also provide the evaluating advisory capacities of judgment, common sense, and conscience. They do not use learned language but rather express themselves in sensed impressions just as we express evaluations of the current situation in involuntary facial and vocal expressions (which, to be sure, may also be consciously imitated).

Whether or not we are willing to acknowledge the intangible influence of some power beyond self, it is increasingly clear that the influence exerted through the autonomic mental bodies is not to be denied. The scientific test of acceptability of a theory is whether or not it works. We know from experience that the man who has judgment backed by intellectual integrity and conscience has the secret ingredient with which we prefer to deal.

The self-centered mental diseases of inadequate faith, egophobia, and egomania are all too common among engineers, executives, and educators. We must be interested in them, for they stunt or paralyze judgment. We, who must hire engineers, cannot help but be impressed with the inadequate development of their judgment and capacity for organization of thought. Yet the reason is obvious. Taking for granted or actually denying the higher facilities of the inner metal bodies, our educational systems are directed only to developing the utility of the subordinate cerebral cortex. The stress on haste and the often misplaced emphasis upon the infallibility of the texts leaves no place for development of the stimulating advisory facilities of the autonomic system.

Data are available to establish our basic science on an understanding of the whole set of mental bodies. I move that we do so, as a part of human engineering and perhaps of ergonomics.

Author's Closure

The author is indebted to Messrs. Simons and Crane for their contributions. Both have enlarged upon the need for a program in ergonomics within the ASME which has as its ultimate objective the regular utilization by engineers of the principles and laws which govern human response to external stress, along with those of the physical world in the design of machines and other engineering structures. Mr. Simons has expressed the purpose succinctly: "to maximize the man-machine relationship." Thus it is the responsibility of the design engineer to give equal recognition in his analysis and design to human capabilities and limitations and to the physical laws that determine the functional capacities and limitations of the machine. Mr. Simons visualizes "steam tables" and "hardenability charts" for man but it must be remembered that the development of such tables and charts of physical relationships was preceded by the formulation of underlying principles and laws and their translation into meaningful engineering terms. A similar order of development is needed for the progress of ergonomics.

Mr. Crane has properly called attention to the complex mental processes of man and his superior position in the man-machine relationship. In the ultimate development of ergonomics, especially as it applies to the automatic industrial machines and processes of the future, these human attributes and limitations of higher order must be given proper consideration "to maximize the man-machine relationship." The present-day limitations in the understanding of many of these human attributes, even by the specialists (psychologists, psychiatrists) in this area, need not discourage engineers from starting to apply the principles of ergonomics in engineering design. We may look forward to remarkable advances in the scientific study of man and, in the meantime, there are many problems to be solved which are much more elementary in nature. To mention a most common and "simple" one: What factors determine the optimum work height for the accomplishment of a given task on a bench or assembly line? A more complex example, which is now under active study by psychologists and engineers, has to do with the design and layout of meter dials and other sources of information to insure that the operator received essential information in the most effective manner and sequence for proper interpretation, decision, and action. The benefits to be derived for such studies have been demonstrated, notably in the design of controls in modern aircraft.

In closing this discussion, the author wishes to acknowledge many letters from engineers, psychologists, and others who have commented favorably on the proposed program in ergonomics. These letters indicate rather widespread interest and all have emphasized the need for teamwork at the operating level between engineers and the many specialists in the biological and behavioral sciences for the full development of this field.

T. F. Hatch.[5]

Engineer Abroad

Comment by H. J. Vetlesen[6]

As a member of a firm of consulting engineers with rather extensive interests in projects abroad, the writer has read this excellent paper,[7] with particular care. He is in full accord with the statements made and his remarks will be limited to emphasizing a few points as a result of his observations in the United States and abroad.

As the author brings out, engineering is a practical application of scientific principles rather than a pure science. It follows that engineering is empirical in nature. Only through actual performance and observation can we establish the results. However, practical applications of new principles require investments and, since the possibility of failure is present, the necessary risk

[5] Professor of Industrial Health Engineering, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pa. Mem. ASME.

[6] Vice-President, Gilbert Associates, Inc., Reading, Pa.

[7] "How to Select Consulting Engineers for Work Abroad," by W. R. Herod, Mechanical Engineering, May, 1955, vol. 77, pp. 405–406.

capital can only be obtained if the economical conditions are favorable.

During the 19th century, Europe had the economical climate necessary for such technical developments and were the leaders in the engineering fields. This was reflected in the high standards of their engineering schools. As the United States developed economically and industrially, they welcomed European engineers and many of the best engineers in this country had European background and contributed materially to our industrial development.

With the economical setback in Europe after the first world war and the further terrific destruction during the second world war, it was the United States that took over the leadership in engineering. This was primarily due to the more favorable economic climate in the United States, which allowed the American engineer to put his theories into practice and, through actual performance and observation, to gain greater experience and knowledge.

Europe, having been set back economically, cannot take the risks we are willing to take in this country. As a result, American engineers have assumed leadership in many fields and have been called upon to contribute of their knowledge and experience in Europe and the rest of the world. Let us recognize, however, that we are only paying back a debt from times gone by and that our present leadership in some fields is due more to the favorable conditions for development in this country rather than any inherently greater ability of American engineers. With this attitude of mind, we will find that we also can learn a great deal by keeping our minds open to many valuable suggestions from abroad.

It has been found that engineers abroad are generally better-informed of engineering progress in the United States than we are informed about developments in their countries. We could profit by keeping better-informed on developments abroad. Many innovations have come from abroad. In the power-plant field, we may point to monotube boilers with controlled circulation as an example of design originating in Europe and recently being adopted and further developed here. It is believed that American consulting engineers abroad can contribute greatly to engineering progress in our own country by keeping their eyes open for new ideas and taking part in an exchange of views with engineers abroad.

The author stresses the importance of the consulting engineer's background, not only technically, but culturally. In a very literal sense, an American consulting engineer represents his country abroad. That is particularly true in countries which have had little contact with Americans. Whether we recognize it or not, people abroad will judge our nation from the individual Americans they meet. If we can contribute of our technical knowledge and, at the same time, meet them on a high cultural level, we will be real ambassadors of good will. It is believed more effort should be made to have American engineers learn the language and the culture of the country to which they are assigned.

Our organization has arranged courses in foreign languages for those of our engineers going abroad. We have found that it leads to better understanding, closer friendships, and a freer interchange of knowledge and experience between our own engineers and those of foreign countries.

Consulting engineers with the right knowledge and background can contribute materially to closing the gap between nations all over the world.

Author's Closure

The author is thoroughly in agreement with Mr. Vetlesen's comments and with the points which he has made, particularly as to the desirability of our engineers keeping their eyes open regarding developments abroad, and the historical factors of economic opportunity tending to promote leadership in engineering. His comments on better understanding both on a cultural as well as a technical plane are well expressed.

W. R. Herod.[8]

Water-Lubricated Bearings

Comment by Walter C. Troy[9]

The authors of this paper[10] have furnished a very useful survey of their comprehensive work on water-lubricated bearings. A presentation of individual test details would be needlessly cumbersome, and the important concepts have been recorded concisely with relatively little detailed test data.

As in most bearing-journal applications, the materials themselves are important chiefly during transient periods of poor lubrication. It is during these periods that significant contact occurs between the members. The present investigation has shown good performance with materials that are intrinsically brittle and nonweldable. Both these factors promote the harmless character of any debris that is formed. Further, the lack of any measurable capacity for plastic deformation in the materials obviates the possibility for progressive surface damage by cold flow.

The single disadvantage of the foregoing situation is that the brittle components are vulnerable to shock loading and cannot sustain minor permanent deformation without ultimate rupture. Without considering the metal-bonded carbon bodies, this disadvantage can be interpreted as an argument in favor of the cast-alloy materials (stellite grades). Although the wear record of the cast alloys is not as impressive as that of the completely brittle materials (ceramics and carbides), would the authors feel that they might still be preferable because of their ability to absorb at least minute amounts of deformation without ultimate rupture?

Authors' Closure

The authors' answer to Mr. Troy's question is "no." Our experience to the present time indicates that properly supported and restrained brittle materials are capable of handling a good degree of shock without noticeable change. A theoretical approach to the subject of proper support may be made on the basis of the avoidance of tensile stresses during shock.

W. M. Wepfer.[11]
E. J. Cattabiani.[12]

Engineering Costs

Comment by J. B. Saxe[13]

The author is to be congratulated on his coverage of a difficult subject.[14]

For each project, there is an economical point for development of engineering and design. If the engineering and design are underdeveloped, the result is an

[8] President, International General Electric Company, New York, N. Y. Mem. ASME.
[9] Armour Research Foundation of the Illinois Institute of Technology, Chicago, Ill.
[10] "Water-Lubricated-Bearing Development Program," by W. M. Wepfer and E. J. Cattabiani," Mechanical Engineering, May, 1955, vol. 77, pp. 413–418.

[11] Supervisory Engineer, Atomic Equipment Department, Westinghouse Electric Corporation, Cheswick, Pa.
[12] Development Engineer, Atomic Equipment Department, Westinghouse Electric Corporation, Cheswick, Pa. Mem. ASME.
[13] Chief Engineer, Gibbs and Hill, Inc., New York, N. Y. Mem. ASME.
[14] "Controlling Engineering Costs," by K. W. Reece, Mechanical Engineering, May, 1955, vol. 77, pp. 419–421.

increase in field and construction costs far exceeding any saving in the design costs. On the contrary, the design can be over-developed to a point where there is no saving in field and construction costs to offset the increase in design costs. The minimum over-all cost can be achieved only where the design and construction forces are working together as a cohesive team, as mentioned by the author.

While changes can never be eliminated, a plurality of changes is an indication that important features are not receiving sufficient study before they are released for design.

Periodic cost reports are informative in many ways. However, when they indicate excessive costs, it is often too late; that is, the damage was done some time ago. An important decision was delayed a month or two ago or essential information was delayed a month ago but has since arrived. Control of cost lies mostly in the experience and skill of the project engineer or co-ordinator in seeing that decisions are made on time and that information arrives on time.

Cost consciousness can be fostered by rewarding those who consistently achieve low costs.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

Metal-Cutting Science

Grundzüge der Zerspanungslehre. By Max Kronenberg. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, Second Edition, 1954. Available in the United States from Lange, Maxwell and Springer, Inc., New York, N. Y. Cloth, $5^3/_4 \times 9$ in., 293 figs., tables, appendixes, name and subject indexes, xxvi and 430 pp., 48 DM.

Reviewed by Richard D. Gross[1]

Max Kronenberg's book "Fundamentals of Metal-Cutting Science and Practice," volume one, on single-point cutting, which has been recently published, is a complete course on the subject. Written in German, it is a completely revised edition of the author's book of the same title published in Germany in 1927. Dr. Kronenberg is a consulting engineer in Cincinnati, Ohio, and a member of the ASME. He is a prominent figure in metal-cutting circles both here and abroad and has written many papers for technical groups starting in the early twenties. This volume is a carefully planned book, not a collection of technical papers. It is the author's major written contribution to this field of knowledge. Containing over 400 pages, it is knit together by a consistent mathematical and logical framework.

The book consists of two parts. The first part deals with the findings of research, primarily laboratory studies, in basic metal cutting. The second deals with applied metal-cutting principles and practice for turning operations. Subsequent volumes, not yet published, will continue the treatment of applied metal-cutting science in drilling, milling, and other machining operations.

In both parts of the book, the collection, summarization, and review of the work of many other investigators performed in the process of deriving the laws of metal cutting is in itself a timesaving and helpful contribution to the average engineer who would be hard put to find the source material for himself. The encyclopedic scope of this work spans the field of metal-cutting studies from most of the industrial countries of the world published over the past 50 years.

Starting with a survey of the mechanics of the metal-cutting process, Dr. Kronenberg analyzes published research studies on chip compression, shear angle, coefficient of friction, and the forces acting in the well-known tool and chip diagram. Persons with an understanding of the techniques of dimensional analysis will be interested in the next chapter which presents the author's use of this method to establish relationships between tool life, chip cross section, cutting speed, cutting pressure, and heat generated. A chapter on thermodynamic phenomena in the cutting process and one on tool geometry complete the section on basic metal-cutting science.

The problem of establishing cutting formulas, which is the main concern of the author in the applied section of the book, is one of determining mathematical relations between a number of dependent variables. To do this, the author examines all available data on the influence of the factors, compares and standardizes formal mathematical relationships, and then tests calculated values against the experimental data. This is an exacting job because it is necessary to correct for the varying conditions under which the data were gathered in order to obtain valid comparisons.

Although there are many facets to the author's reasoning, the reviewer takes the risk of possible oversimplification by saying that Dr. Kronenberg essentially resolves the laws of metal cutting into two equations: one for cutting speed, and one for cutting force. Cutting speed is equal to specific cutting speed corrected for the influence of size and shape of chip. Cutting force, likewise is equal to specific cutting pressure corrected for the influence of size and shape of chip. Let us examine briefly the components of these equations.

Experimentally by tests both in shop and laboratory, we can determine cutting speed under controlled conditions of depth, feed, and tool life. This is called specific cutting speed. Similarly, we can determine the cutting force per unit area of chip cross section again under controlled condition. This is called specific cutting pressure. Both of these concepts will be recognized as twin aspects of machinability.

A factor in Dr. Kronenberg's cutting-speed formula can be said to be the "tool-life" index of machinability while a factor in his cutting-force formula is the "energy per unit cube of metal removal" or "cutting-pressure" index of machinability.

In particular cases in the shop, we all know that corrections to the cutting speed have to be made for size and shape of chip. We know that heavy feeds and deep cuts require slower speeds than light cuts and fine feeds. We also know that speeds can be increased if a thin ribbon-like chip, say $^1/_2$ in. depth $\times$ 0.010 in.

[1] Staff Industrial Engineer, Baldwin-Lima-Hamilton Corporation, Eddystone Division, Philadelphia, Pa.

feed rather than $^{1}/_{4}$ in. depth $\times$ 0.020 in. feed is being cut. We also know that coarse chips cause high cutting forces.

His formulas for cutting speed and cutting force therefore consist essentially of the respective machinability index multiplied by the appropriate mathematical functions of chip size and shape.

In the appendix of his book, the author tabulates, for practical use, the necessary values to substitute in the formulas to determine the cutting speed, cutting force as well as the derived values of power and metal removal rate. The functions of the chip shape, chip size, and tool life in the formulas are exponential. Some engineers may wish to set up tables for shop use in the form used in the ASME Handbook of Cutting Metals; others may desire to calculate direct from the formulas, while still others might wish to work out graphs on double-log paper, or alignment charts to suit particular operating conditions. The mathematical functions lend themselves to ingenious manipulations to simplify the problems of application. Furthermore, the concepts admit the possibility of expansion as tests of new tool or work materials are made.

The section of the book on cutting force deserves special mention. Most manufacturing engineers in this country have been preoccupied with cutting speed and tool life. The Air Force Machinability Studies are an example of this emphasis. Cutting force, on the other hand, because of its relationship to machine and workpiece rigidity, tool angles, and vibration, requires at least equal consideration. The direction of tool forces is important especially on negative-rake carbide applications, and the author thoroughly discusses this subject.

Among the problems which can be solved by Dr. Kronenberg's formulas are those which fall in the following three categories commonly met:

1 We have a rigid machine or workpiece and wish to determine speed, chip size, and shape to fully utilize the power available.

2 We wish to set the speed and chip size and shape at such a point that the tool force will not exceed a value which would cause undue spring in a nonrigid workpiece.

3 We are taking a light finishing cut at a fine feed to give high surface finish. We know the chip size and shape and know that we have available more than enough power. What speed shall we use to get the tool life we desire?

The book under review is a handbook for the manufacturing engineer as well as a textbook and symposium for the student. Both will benefit by being freed from the necessity of reliance on rules of thumb or making each machining job the subject of trial-and-error determinations. If these groups do the job which this book makes possible, increased effectiveness on the part of the foreman and worker should follow. Our skill in controlling the variables to establish optimum cutting conditions should be enhanced. Progressive industrial and manufacturing engineers should study Dr. Kronenberg's work and then turn their full attention to the human and organizational problems of putting the principles to work in the shop.

Books Received in Library...

Approximations for Digital Computers. By Cecil Hastings, Jr. Princeton University Press, Princeton, N. J., 1955. 201 p., $9^{1}/_{2} \times 6^{1}/_{4}$ in., bound. \$4. "This monograph deals with the subject of best approximation in the sense of Chebyshev as applied to the problem of making univariate functional data available to the high-speed digital computing machine." (Pref.) It includes seventy-four approximations, each with a carefully drawn error curve, and an introduction dealing with the use and construction of such approximations.

Bessel Functions for Engineers. By N. W. McLachlan. Oxford University Press, New York, N. Y., second edition, 1955. 239 p., $9^{1}/_{2} \times 6^{1}/_{4}$ in., bound. \$5.60. Intended for all students of applied mathematics, this book sets out the theory in logical sequence and provides worked examples illustrating a wide range of analytical processes and applications: water-waves, flexible membranes, loud-speaker horns, electrical transmission lines, bars and plates, eddy-current heating, heat diffusion in engine cylinders, etc. The book has been considerably revised from the earlier edition.

Bibliographic Survey of Corrosion, 1950–1951. National Association of Corrosion Engineers, Houston, Texas, 1955. 435 p., $11^{1}/_{4} \times 8^{1}/_{2}$ in., bound. \$12.50 (members \$10). This compilation of 4454 abstracts is the fourth in a series covering 1945 to 1951. As in previous volumes, the abstracts are arranged by specific subdivisions under the eight main groups of the NACE filing system: general, testing, corrosion phenomena, corrosive environments, preventive measures, materials of construction, equipment, and industries. An author index and a detailed subject index complete the volume.

Case Studies in Industrial Management. By J. M. Juran and Norman N. Barish. McGraw-Hill Book Company, Inc., New York, N. Y., 1955. Various paging, $11^{1}/_{4} \times 9^{1}/_{4}$ in., spiral binding. \$5. Each of the sixteen studies included deals with a separate phase of the operation of a single company, The Burndy Engineering Company: financing, organization, product development, plant location, manufacturing planning, plant layout, plant maintenance, etc. Intended as a laboratory manual for students of industrial management, the book is fully illustrated with photographs, diagrams, and reproductions of actual business papers.

Coordination, Control, and Financing of Industrial Research. Edited by Albert H. Rubenstein. King's Crown Press, Columbia University, New York, N. Y., 1955. 429 p., $8^{3}/_{4} \times 5^{3}/_{4}$ in., bound. \$8.50. This volume constitutes the Proceedings of the fifth annual conference on Industrial Research with some selected papers from the fourth conference. A wide range of topics is covered by authorities both from top-management positions in industry and from university staffs. Abridged notes of the clinic sessions are included as well as the formal papers.

Die Dampfturbinen. By C. Zietemann. Springer-Verlag, Berlin, Germany, second edition, 1955. 494 p., $10 \times 6^{3}/_{4}$ in., bound. 43.50 DM. A comprehensive standard treatise on the theoretical principles, design, and construction of steam turbines and turbine components. Separate chapters cover details of special-purpose turbines, fundamentals of flow, thermal analyses, regulation, and discussion of high-pressure turbines in Germany and other countries. A wealth of sketches and practical examples is included.

Diesel Engine Catalog. Volume 20, 1955–1956. Edited by Rex W. Wadman. *Diesel Progress*, Los Angeles, Calif., 1955. 368 p., $13^{3}/_{4} \times 11$ in., paper. \$10. The new edition of this annual guide to the diesel industry provides concise, comprehensive information on engines and auxiliary equipment of the major manufacturers. Designs and developments of the past year have been added, and the accessories section has been expanded.

Elements of Physics. By George Shortley and Dudley Williams. Prentice-Hall, Inc., New York, N. Y., second edition, 1955. 880 p., $9^{1}/_{4} \times 6$ in., bound. \$10. An operational approach to classical physics, covering mechanics, heat, light, wave motion and sound, electricity and magnetism, together with a selection of modern topics—electromagnetic waves, photons, electrons, and nuclear physics. A wide variety of examples and problems from actual physical and engineering situations is provided for the benefit of engineering students and others not majoring in pure physics.

Faltwerke. By Joachim Born. Konrad Wittwer, Stuttgart, Germany, 1954. 204 p., $9^{1}/_{2} \times 6^{1}/_{2}$ in., bound. 21 DM. A detailed treatment of the theory and structural analysis of prismatic and pyramidal structures, i.e., structures composed of flat planes or panels. A considerable variety of forms and sizes are dealt with and certain special aspects are considered, for example the buckling of such structures or structural elements.

Farm Machinery and Equipment. By Harris Pearson Smith. McGraw-Hill Book Company, Inc., New York, N. Y., fourth

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edition, 1955. 514 p., $9^1/_4 \times 6^1/_4$ in., bound. $7.50. All types of equipment for producing, handling, and processing farm crops are covered, including machinery for tillage, planting, weed-control, spraying, fertilizing, and harvesting. Obsolete material has been eliminated from this edition, and new information has been added on loaders and other power equipment, lubricants and lubrication, drying equipment, and a number of other subjects.

Fliessen und Kriechen der Metalle. By Wilhelm Späth. Metall-Verlag, Berlin, Germany, 1955. 160 p., $8^1/_2 \times 6$ in., bound. 13.50 DM. This concise presentation of current knowledge on the flow and creep of metals is presented for the use of both practicing and research metallurgists. Physical fundamentals, slip lines and slip bands, physics of slip phenomena, static tests, creep-test phenomena, and the behavior of materials under dynamic loading are among the important topics covered.

Formazione del Truciolo Metallico. By F. Alberto Isnardi. Ulrico Hoepli, Milan, Italy, second edition, 1955. 269 p., $9^3/_4 \times 7$ in., paper. 2600 Lire. A revised and enlarged edition covering progress and development in metal cutting, which devotes particular attention to the analytical and mathematical considerations of the mechanics of cutting in the lathe. A detailed summary is given of the principal contributions to the literature from 1877 to 1953. The turning of some nonmetallic materials is briefly considered, chiefly as analogous to metal cutting.

How to Solve Problems in Elementary Engineering Mechanics. (Engineering Mechanics—Book I.) By Stephen J. Tracy, Jr., 166–24 26th Avenue, Flushing 58, N. Y., 1954 200 p., $8^3/_8 \times 5^1/_2$ in., paper. $2. A sequence of progressive problems illustrating basic principles of statics, structures, and elementary kinematics is presented, with accompanying step-by-step solutions, mainly analytical. Although written specifically for undergraduate students, the book may be helpful to engineers preparing for examinations.

How to Train Engineers in Industry. (Executive Research Survey, no. 4.) National Society of Professional Engineers, Washington, D. C., 1955. 72 p., 9×6 in., paper. $2. An analysis of the experience of more than 200 companies and the opinions of many individual leaders in the training field. It covers, among other things, typical training programs, how to train the "trainers," and guidance toward professionalism.

Industrial Ventilation. A Manual of Recommended Practice. American Conference of Governmental Industrial Hygienists, Committee on Industrial Ventilation, Lansing, Mich., 1954. Various paging, $11 \times 8^1/_2$ in., spiral binding. $3. The purpose of this manual is to meet the needs of official industrial-hygiene agencies for a ready single source of recent data on industrial exhaust ventilation, for standardizing ventilation practices, and for training purposes. The many sketches, graphs, and data tables make the manual useful for anyone, such as the plant engineer, who must deal with ventilation problems.

Information Processing Equipment. Edited by M. P. Doss. Reinhold Publishing Corporation, New York, N. Y., 1955. 270 p., $9^1/_4 \times 6$ in., bound. $8.75. This book describes a wide variety of commercially available equipment for the preparation and reproduction of reports and for the recording and handling of information: automatic typewriters, stencil-producing machines, microfilm cameras and readers, equipment for dry photographic copying, dictating machines, punched cards, calculators, computers etc. Lists of manufacturers and suppliers are included.

Irrigation and Hydraulic Design. Volume I: General Principles of Hydraulic Design. By Serge Leliavsky, Chapman & Hall Ltd., London (distributed in U. S. by Macmillan Company, New York, N. Y.), 1955. 492 p., $10 \times 7^1/_2$ in., bound. $25. The present volume, the first of a projected three-volume study, is devoted to three main topics: percolation as a structural-design factor, tail erosion, and the hydraulics of canals and rivers. Detailed consideration is given to such specific subjects as flow of water through a pervious soil, methods for flow-net diagrams and seepage study, erosion of solid work (including cavitation), uniform and nonuniform flow, and others. A large number of charts, diagrams, and photographs illustrate the text.

Materials for Nuclear Power Reactors. By Henry H. Hausner and Stanley B. Roboff. Reinhold Publishing Corporation, New York, N. Y., 1955. 224 p., $7 \times 4^3/_4$ in., bound. $3.50. Another in a series of concise summaries of essential information on new developments in various fields of science and technology. The present volume deals with criteria for selecting materials for shielding, for cladding of fuel elements, for moderators and reflectors, and for most of the important parts of a reactor. The material is presented in a form understandable to the layman with some technical background.

Mecánique Vibratoire. By Robert Mazet. Librairie Polytechnique Ch. Béranger, Paris, France, 1955. 280 p., $9^5/_8 \times 6^1/_4$ in., bound. 4975 fr. Beginning with the fundamentals of vibrating systems, this text continues with analytical discussion of the dynamics of various characteristic systems. Analogies are pointed out among the phenomena of several branches of physics—mechanical, electrical, acoustical, etc. The aerodynamic aspects of vibration, such as flutter, are given particular attention.

Metal Beryllium. Edited by D. W. White, Jr. and J. E. Burke. American Society for Metals, Cleveland, Ohio, 1955. 703 p., $9^1/_4 \times 6^1/_8$ in., bound. $8. Owing to the currently increasing interest in beryllium a group of ASM conference papers together with some additional material has been edited to provide an over-all reference book on the subject. The several chapters deal with the importance of beryllium, its ores, reduction of the ores, fabrication of the metal, properties, metallography, corrosion, alloys and cermets, health hazards, chemistry, and the special problem of brittleness of the metal. Each chapter includes a bibliography.

Metals Reference Book. By Colin J. Smithells. Interscience Publishers Inc., New York, N. Y., second edition, 1955. Two volumes, $10 \times 6^1/_4$ in., bound. $25 a set. A convenient and comprehensive summary of a wide range of physical, mechanical, and electrical data relating to metallurgy and metal physics. In this new edition, new values have been substituted where more recent and reliable information has become available, several sections have been rewritten, and new sections have been added covering elastic properties and damping capacity, physical properties of molten salts, and friction. The presentation is largely in tabular form, with brief monographs included where information could not otherwise be adequately given.

1946–1948 Bibliography of Rubber Literature. Division of Rubber Chemistry, American Chemical Society. *Rubber Age*, New York, N. Y., 482 p., $9^1/_4 \times 6^1/_8$ in., bound. $7.50. Some 6000 references are provided on the chemistry, engineering, and technical economics of rubber taken from hundreds of industrial, technical, and trade publications of all countries. The items are broadly classified into 69 major headings covering raw rubber, chemical aspects, processing methods, and a wide range of applications. Author and subject indexes are provided. Although still some years behind, the aim is to have the indexing up to date by 1957.

Notes and Formules de L'Ingénieur. Albin Michel, Éditeur, Paris, France, twenty-third edition, 1938–1955. Four volumes, $7^1/_2 \times 5$ in., bound. 16,252 fr. a set. Some 7500 pages in 4 volumes provide an extensive compilation of data for engineers of all kinds. The respective volumes cover the following topics: (1) mathematics, mechanics, hydraulics, heat and heating, steam power; (2) fluid mechanics, refrigeration, metallurgy, mining, gas plants, railroads, highways, internal-combustion engine-hoisting equipment; (3) motor vehicles, aerodynamics and airplanes, general electricity; (4) electrical engineering, telecommunications, electronics, electric traction. Some special topics such as the preparation of manuscripts are also included.

Plastics in Building. Building Research Institute. National Research Council, Washington, D. C., 1955. 149 p., $11^1/_4 \times 8^1/_2$ in., bound. $5. Reflecting the growing influence of plastics in the building field this conference report presents three introductory papers, seven papers on specific uses such as interior panels, piping, and ducts, two on standards and codes, and four summarizing the conference activities and previewing future uses. There is also a brief report on sprayed-on plastic sheetings.

Plastics Tooling. By Malcolm W. Riley. Reinhold Publishing Corporation, New York, N. Y., 1955. 123 p., $7 \times 4^3/_4$ in., bound. $2.50. This small book summarizes essential information in language understandable to the nonexpert. Briefly discussed are advantages and disadvantages of plastics tools; characteristics and uses of the principal tooling resins; methods of forming; and uses of plastics for checking, locating, and assembling fixtures, metal-forming tools, die models and prototypes, and plastics-forming tools.

Proceedings of the Eighth Annual Conference on the Administration of Research, 1954. New York University Press, New York, N. Y., 1955. 108 p., $11 \times 8^1/_2$ in., paper. $4. The conference papers are devoted to various aspects of the following broad subjects: appraising and rewarding the researcher's output; management in the research laboratory; communication problems; physical facilities; and basic research in an applied-research laboratory. Some of the specific topics of the twenty-four papers are merit raises, qualifications of an engineering manager, communication with management, designing buildings for research, and the use of consultants.

Prüfverfahren Zur Ermittlung von Höchstleistungen in Kugel und Rohrmühlen. By Carl Mittag, 1954, Springer-Verlag, Berlin, Germany, 41 p., $8^1/_4 \times 5^3/_4$ in., paper. 6 DM. This booklet describes a test method for determining maximum power

requirements in ball and tube mills. A laboratory drum mill was used under controlled conditions for particular materials and the results are extrapolated for existing full-scale continuous ball and tube mills.

Pulvermetallurgie. By M. Ju. Balschin. Wilhelm Knapp Verlag, Halle (Saale), 1954. 285 p., $8^1/_2 \times 6$ in., bound. 12.70 DM. This small treatise on powder metallurgy is a German translation of a Russian book of 1946. It covers powder-metallurgy methods, manufacturing techniques, and applications. There is a considerable bibliography drawn largely from Eastern European sources.

Regelungstechnik. Edited by Fachausschuss für Regelungstechnik des VDI and des VDE. 1954, Deutscher Ingenieur-Verlag, Düsseldorf, Germany. 282 p., $9^3/_4 \times 6^1/_2$ in., bound. 24 DM. A compilation of 27 lectures on control engineering grouped under the following headings: fundamentals; technology of regulators; process-controlled systems and regulators; regulators for the process industries; regulation of drives; regulation of power plants and electrical networks; control of a d-c generator; brief glossary of equivalent German, British, American, and French terms.

Review of Metal Literature. Volume 11, 1954. Edited by Marjorie R. Hyslop, abstracts by Stewart J. Stockett (Battelle Memorial Institute). American Society for Metals, Cleveland, Ohio, 1955. 831 p., $6 \times 9^1/_4$ in., bound. $15. This useful annual guide to metallurgical literature includes brief indicative abstracts drawn from a wide range of English and foreign-language books and periodicals. Abstracts are listed under broad headings relating to processes and properties and are fully indexed by subject. The volume also includes an author index and a list of the periodicals abstracted.

Scholarships, Fellowships and Loans. Volume 3. By S. Norman Feingold. First edition, 1955, Bellman Publishing Company, Cambridge, Mass. 471 p., $9^1/_2 \times 6^1/_2$ in., bound. $10. Administering agencies of scholarships, fellowships, and loans are listed alphabetically with address, qualifications, funds available, special fields of interest, and information on where to apply. Subject and name indexes to agencies in the present volume, and an index by vocational goals or fields of interest covering all three volumes in the series are provided. Although agencies previously listed are included in the present volume, the information given is new.

Science of Petroleum. Volume 5, part 3: Refinery Products. Edited by B. T. Brooks and A. E. Dunstan. Oxford University Press, New York, N. Y., 1955. 397 p., $11^1/_4 \times 8^1/_4$ in., bound. $32.50. Twenty-three papers prepared by American and British petroleum technologists review the latest advances in gas-turbine fuels, aviation gasoline, lubricating-oil additives, boundary lubrication, various testing methods, mass spectrometry, Raman spectroscopy, and other subjects. Each paper has a comprehensive bibliography. The volume is indexed by subjects and names.

Society of Plastic Engineers. Papers presented at Eleventh Annual National Technical Conference, Atlantic City, N. J., January, 1955. (An official publication of the society, volume 1.) Available from Society of Plastic Engineers, Greenwich, Conn., 530 p., $8^1/_2 \times 5^1/_2$ in., paper. $7.50. The subjects treated in the fifty papers included cover a wide range of subjects in plastics engineering: properties, design, molding, fabricating, and applications of many types of plastics. Representative papers deal with sandwich panels, laminates for printed circuits, plastic pipe, plastics in the atomic-energy program, and engineering applications of silicone rubber.

Solar Energy Research. Edited by Farrington Daniels and John A. Duffie. University of Wisconsin Press, Madison, Wis., 1955. 290 p., $9^1/_2 \times 6^1/_4$ in., bound. $4. Based in part on a symposium held at the University of Wisconsin in 1953, this volume includes reports by thirty-one contributors on the present status of the utilization of solar energy. Space heating, power plants, large-scale furnaces, and a wide range of other uses of solar energy are discussed in the eleven sections into which the book is divided. A bibliography is included.

Some Fundamentals of Combustion. (Gas Turbine Series, Volume 2.) By D. B. Spalding. 1955, Academic Press, Inc., New York, N. Y., 250 p., $6 \times 9^3/_4$ in., bound. $7.50. Brief chapters are included on selected aspects of heat and mass transfer, thermodynamics, and fluid flow; somewhat longer chapters on heat and mass transfer with chemical reaction and chemical features of combustion. The latter deal with such specific topics as combustion of gas jets, combustion of pre-mixed gases, and combustion without pre-mixing. Some of the guiding principles for gas-turbine design are discussed in the concluding chapter.

Starkstromtechnik. Part 3. By E. v. Rziha. Wilhelm Ernst & Sohn, Berlin, Germany, eighth edition, 1955. 379 p., $8^1/_4 \times 5^7/_8$ in., paper. 23 DM. This part 3 concludes the first volume of a proposed two-volume set on heavy-current technology. It contains chapters on steam, hydroelectric, and wind-motor plants, their planning, machinery, switchgear, and selective protection. The index and table of contents to all of volume 1 come with this concluding part.

Statistical Mechanics of Irreversible Change. By Richard T. Cox. Johns Hopkins Press, Homewood, Baltimore, Md., 1955. 130 p., $9^1/_4 \times 6$ in., bound. $5. The four main sections of this small work on modern thermodynamics are as follows: statistical theory of thermodynamic equilibrium; viscous forces and Brownian motion; transport phenomena; the constrained approach to equilibrium. The author, although ignoring the molecular details of structure, utilizes a statistical treatment of microscopic details of change.

Steuerung des Gaswechsels in Schnellaufenden Verbrennungsmotoren. (Konstruktionsbücher, 16.) By Wolf-Dieter Bensinger. Springer-Verlag, Berlin, Germany, 1955. 93 p., 9×6 in., paper. 12 DM. A detailed treatment of porting, scavenging, etc., in high-speed internal-combustion engines. The more than 100 sketches and diagrams which illustrate the text effectively add to the practical value of the work.

Strength of Materials. Part 1: Elementary Theory and Problems. By S. Timoshenko. Van Nostrand Company, Inc., New York, N. Y., third edition, 1955. 442 p., $9^1/_4 \times 6$ in., bound. $6. The third edition of this standard work has been expanded by the addition of two new chapters, one on the bending of beams in a plane which is not a plane of symmetry, the other on the bending of curved bars. A number of minor changes have been made throughout the book, and new problems have been added.

Tables of Sines and Cosines for Radian Arguments. (Applied Mathematics Series, No. 43.) National Bureau of Standards. Available from Superintendent of Documents, Government Printing Office, Washington 25, D. C., 1955. 278 p., $10^1/_2 \times 8$ in., bound. $3. Sine and cosine values are given to eight decimals, at intervals of 0.001, over a range of 25.2 radians, the approximate equivalent of four complete circles. An introductory section describes methods of both direct and inverse interpolation. This is reissue of Mathematical Table MT4 of the WPA series, with an extension of the range and a few corrections and changes.

Theoretical Structural Metallurgy. By A. H. Cottrell. St. Martin's Press, Inc., New York, N. Y., second edition, 1955. 251 p., $8^5/_8 \times 5^1/_2$ in., bound. $4.50. An account for students of the ways in which the ideas of atomic mechanics can be applied to problems of metals and alloys. Using only elementary mathematics, the author treats descriptively selected topics centered around the electron theory of metals and the statistical thermodynamics of metals and alloys. New in this edition are the discussions of the theory of dislocations, surface tension of grain boundaries, and the physical chemistry of carbon and nitrogen in ferrite.

Tiefziehen. By E. Siebel and H. Beisswänger. Carl Hanser Verlag, Munich, Germany, 1955. 205 p., $8^1/_4 \times 6$ in., bound. 14.80 DM. A group of 12 papers discussing the results of a series of investigations on deep drawing made between 1951 and 1953. The papers provide a review of the present state of knowledge concerning the behavior of metals in the plastic state, deep-drawing procedures, and methods of testing the materials used.

Tool Design. By William R. Jeffries. Prentice-Hall, Inc., New York, N. Y., 1955. 217 p., $8^1/_2 \times 5^1/_2$ in., bound. $6.35. Intended for the reader with no previous knowledge of the subject, this book gives detailed instructions for the design of jigs and fixtures, weld and assembly fixtures, punch-press tooling, and hydraulic-press tooling. Presswork-ing machines and tools, clamps, and methods of clamping and locating are also treated.

Transform Calculus. (With an introduction to complex variables.) By E. J. Scott. Harper and Brothers, New York, N. Y., 1955. 330 p., $6^1/_2 \times 9$ in., bound. $7.50. Intended mainly for engineers and others interested in applications of mathematics, this text emphasizes the use of transforms in the solution of physical problems covering a considerable range of topics: vibration of rods, flutter, beam deflection, diffusion, networks, and transmission lines. The Laplace transform, as the most useful, receives the greatest attention, although other integral transforms are also considered.

Thermodynamics and Physics of Matter, (High Speed Aerodynamics and Jet Propulsion, Volume I.) Edited by Frederick D. Rossini. Princeton University Press, Princeton, N. J., 1955. 812 p., $9^1/_2 \times 6^1/_2$ in., bound. $15. A thorough treatment of basic principles is presented in ten sections covering fundamentals of thermodynamics; physics of gases; thermodynamic properties of real gases and mixtures of real gases; transport properties of gases and gaseous mixtures; critical phenomena; liquids and liquid solutions; solids and solid solutions; relaxation phenomena in gases; and the thermodynamics of irreversible processes. Selected bibliographies accompany each section.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

As NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.

(The following proposed revisions were formulated at the Committee meeting June 23, 1955, and approved by the Board on September 2, 1955.)

Power Boilers, 1952

PAR. P-24(1) Revise as follows: "For piping from the boiler to and including the required stop valve and the check valve, the value of *P* shall exceed the maximum allowable working pressure of the boiler by either 25 per cent or 225 psi whichever is less. For an installation with an integral economizer, without valves between the boiler and economizer, this paragraph shall apply only to the piping from the economizer inlet header to and including the required stop valve and the check valve."

PAR. P-24(3) Revise as follows:

The *S* value used shall not exceed that permitted for a temperature corresponding to the temperature of saturated steam at the maximum allowable working pressure of the boiler.

PAR. P-24(4) Revise as follows:

The value of *P* in the formula shall not be taken at less than 100 psi for any condition of service or material, and shall never be less than the pressure required to feed the boiler.

In the twelfth line on page 10, delete "(extra strong)."

PAR. P-25 Revise as follows:

P-25 ***Blowoff Piping*** The blowoff piping shall conform to the requirements of Pars. P-9 and P-300, except that galvanized wrought iron or steel, brass, or copper pipe shall not be used.

The minimum thickness of all blowoff piping between the boiler and the valve or valves required by Par. P-311 shall be determined by the formulas in Par. P-23, but with values of *P* and *S* as defined below.

(1) The value of *P* shall exceed the maximum allowable working pressure of the boiler by either 25 per cent or 225 psi whichever is less. The value of *P* shall not be less than 100 psi in any case. The thickness shall not be less than listed for Schedule 80 pipe.

(2) The value of S shall not exceed that permitted for a temperature corresponding to the temperature of saturated steam at the maximum allowable working pressure of the boiler.

PAR. P-299(c) Revise the second paragraph as follows:

Valves and fittings made of any material permitted by this section of the Code for primary service pressure ratings of 100 lb or more and marked as required by the Code may be used for saturated steam service up to their adjusted pressure-temperature ratings, except that in no case shall they be used for temperatures exceeding those shown for stresses in Tables P-6 and P-7, or permitted by Par. P-12, for the materials used.

PAR. P-299(d) Revise the first paragraph as follows:

(d) All valves and fittings on all feedwater piping from the boiler to and including the first stop valve and the check valve (Par. P-317) shall be equal at least to the requirements of any standard accepted by this section of the Code for a pressure that shall exceed the maximum allowable working pressure of the boiler by either 25 per cent or 225 psi whichever is less except as otherwise stated in (c) and for a temperature corresponding to the temperature of saturated steam at the maximum allowable working pressure of the boiler. In no case shall the pressure be less than the pressure required to feed the boiler. For an installation with an integral economizer, without valves between the boiler and economizer, this paragraph shall apply only to the valves and fittings from the economizer inlet header to and including the required stop valve and check valve.

PAR. P-299(d) Delete the last part of the second paragraph beginning with the words "and for a saturated steam temperature corresponding..." and substitute the following:

... and for a temperature corresponding to the temperature of saturated steam at the maximum allowable working pressure of the boiler.

PAR. P-299(d) Revise the last paragraph as follows:

Except as limited by other paragraphs, valves and fittings made of any material permitted by this section of the Code for primary service pressure rating of 125 lb or more and marked as required by the Code may be used for feed line and blow-off line service provided their adjusted pressure-temperature ratings exceed the maximum allowable working pressure of the boiler by 25 per cent or 225 psi whichever is less. (See Table P-15.) In no case shall they be used for temperatures exceeding those shown for stresses in Tables P-6 and P-7, or permitted by Par. P-12 for the materials used.

PAR. P-308(f) Revise as follows:

All water walls and water screens which do not drain back into the boiler, and all integral economizers shall be equipped with drain or blowoff valves conforming to the requirements of this paragraph, and Pars. P-309 and P-311.

PAR. P-310(c) Revise as follows:

In all cases the valves and fittings from the boiler to and including the required stop valves shall be equal at least to the requirements of the American Standards given in Tables A-5 to A-8 and A-11 for a pressure that shall exceed the maximum allowable working pressure of the boiler, by either 25 per cent or 225 psi, whichever is less (see Table P-15), and for a temperature corresponding to the temperature of saturated steam at the maximum allowable working pressure of the boiler, except that for pressures not exceeding 100 psi, the valves and fittings shall be equal at least to the requirements of the American Standards given in Tables A-7 and A-11 for 125 psi.

PAR. P-311(a) Delete last paragraph.

TABLE P-15 Revise as follows:

TABLE P-15 MAXIMUM BOILER PRESSURE FOR USE OF AMERICAN STANDARD CARBON STEEL PIPE FLANGES, FITTINGS AND VALVES

Primary service pressure rating	Type of flange facing[3]	Maximum Allowable Boiler Pressure, Psig —Except as Noted— Steam service at saturation temperature[1]	Boiler-feed and blowoff line service[2]
150	Class A	190	160
	Class B	180	150
300	Class A	630	515
	Class B	510	415
400	Class A	820	665
	Class B	665	540
600	Class A	1160	970
	Class B	960	785
900	Class A	1640	1450
	Class B	1360	1170
1500	Class A	2500	2325
	Class B	2100	1910
2500	Class A	3206 psia	3206 psia
	Class B	3150	2975

[1] Adjusted pressure ratings for steam service at saturation temperature corresponding to the pressure, derived from Tables 2 to 15, incl., of ASA B16.5–1953.

[2] Pressures shown include the factor for boiler feed and blowoff line service, required by Pars. P-299(d) and P-310(c), corrected for saturation temperature corresponding to this pressure.

[3] Class A ratings apply to welding ends, ring joints, small tongue-and-groove facing with any type of gasket, large tongue-and-groove facing with any type of gasket, except flat solid metal, and other facings with gaskets which result in no increase in bolt load or flange moment over those previously mentioned.

Class B ratings apply to all facings and gaskets not specifically listed under Class A.

TABLE P-7 In the August 1955 issue of MECHANICAL ENGINEERING, revise the factor to read "0.85" instead of ".085" in the last line.

PAR. P-340(b) In the May 1955 issue of MECHANICAL ENGINEERING revise the working pressure to read "40 psi" instead of "50 psi."

Low-Pressure Heating Boilers, 1952

PAR. H-1(5) Delete the words "ASME-approved" and add at the end of the paragraph "in accordance with the Code and of Code construction."

PAR. H-21 Last paragraph, last sentence, revise to read: "A welded joint in a flat surface shall be between two rows of stays which are not over one pitch apart."

PAR. H-24. Add a new subparagraph as (c) to read: "A boiler head may be stayed as a flat surface."

PAR. H-39 In the August 1955 MECHANICAL ENGINEERING, revise the formula for minimum volume of tanks to read:

$$V_t = \frac{(0.00041T - 0.0466)\,V_s}{(P_a/P_f) - (P_a/P_o)}$$

PAR. H-41 Delete.

PAR. H-61 Revise the first sentence to read: "Each steam boiler shall have one or more water gage glasses attached to the water column or boiler by means of valved fittings, with the lower fitting provided with a drain valve of the straightway type with opening not less than $^1/_4$ inch diameter to facilitate cleaning."

PAR. H-62 Delete.

PAR. H-94 Delete.

PAR. H-114 Revise the first sentence to read: "Each steam boiler shall have one or more water gage glasses attached to the water column or boiler by means of valved fittings, with the lower fitting provided with a drain valve of the straightway type with opening not less than $^1/_4$ inch diameter to facilitate cleaning."

PAR. H-115 Delete.

Unfired Pressure Vessels, 1952

PAR. UCI-35(b)(3) Revise to read: "Flanges conforming to the American Standards for cast iron given in Appendix O may be used at the pressures and temperatures permitted in these standards. Other flanges may be designed in accordance with the provisions of Appendix II.

"Alternatively, the allowable working pressure of cast-iron dished covers with bolting flanges, with or without nozzles or internal ribs, may be established in accordance with the provisions of Par. UCI-101."

PAR. UCS-56(c)(3) Add the following to the end of the second sentence: "........except as otherwise provided in (d)".

Add the following new subparagraph (d) and reletter the present subparagraphs (d), (e), and (f) as (e), (f), and (g).

(d) Vessels fabricated of material conforming to SA-353 shall be heated as provided in (c) to a temperature between 1025 and 1085 F. The vessel shall be held for a minimum of two hours for thicknesses up to one in. plus a minimum of one hour for each additional inch of thickness. The rate of cooling shall be as provided in (c).

PAR. UCS-57 Delete "(See Par. UW-11)" at the end of Par. UCS-57 and add: "..... and for each butt-welded joint in vessels built of steel complying with specifications SA-353 and SA-357 for all plate thicknesses."

TABLE UNF-23 Add the following stress values:

Specification number	Specified tensile strength	Minimum yield strength
Copper		
SB-152 Plate Sheet Strip and Bar, Annealed Phosphorus, Deoxidized	30,000	10,000

For Metal Temperatures Not Exceeding Deg F

Subzero to 150	250	300	350	400
6700	6300	5000	3800	2500

Add additional stress values given elsewhere.

FIG. UG-118 In the figure, substitute the words "maximum design pressure" for the present wording "maximum allowable design pressure" in the parenthetical explanations. Substitute the words "maximum design temperature" for the present wording "maximum allowable temperature" in the parenthetical explanation.

TABLE UNF-23

ASME Specification	Alloy	Temper	Specified Minimum Tensile strength, psi	Specified Minimum Yield strength, psi	Notes	Maximum Allowable Stress Values For Metal Temperatures Not Exceeding Deg F: 100	150	200	250	300	350	400
Sheet and Plate												
SB-178	Clad M1A	O	13000	4500		3000	2900	2700	2500	2200	2000	1700
		H112	14500	6000	(1, 4)	3600	3200	3000	2800	2500	2200	1900
		H12	16000	11000	(1)	4000	3800	3600	3400	3100	2800	2500
		H14	19000	16000	(1)	4800	4600	4400	4200	3800	3400	2900
SB-178	Clad MG11A	O	22000	8000		5300	5300	5300	5200	4400	3700	3000
		H112	22000	8500	(1)	5500	5500	5500	5200	4400	3700	3000
		H32	27000	20000	(1)	6800	6800	6800	6300	5600	4900	4100
		H34	31000	24000	(1)	7800	7800	7700	7200	6300	5400	4600
SB-178	GS11A	T4	30000	16000	(5)	7500	7200	7000	6700	6400	5600	4000
		T6	42000	35000	(5)	10500	10200	9900	9400	7900	6200	4400
		T6 Welded	24000*	...		6000	5900	5700	5400	5000	4200	3200
SB-178	Clad GS11A	T4	27000	14000	(5)	6800	6500	6200	6000	5800	5100	3600
		T6	38000	32000	(5)	9500	9200	9000	8500	7200	5600	4000
		T6 Welded	24000*	...		6000	5900	5700	5400	5000	4200	3200
Bars, Rods and Shapes												
SB-273	GS11A	T6	38000	35000	(5)	9500	9200	9000	8500	7200	5600	4000
		T6 Welded	24000*	...		6000	5900	5700	5400	5000	4200	3200
Bolting Materials												
SB-211	GS11A	T6	42000	35000	(5)	8400	8200	7900	7500	6300	4900	3300
		T6 Welded	24000*	...		4800	4700	4600	4400	4000	3400	2600
Pipe and Tube												
SB-274	GS11A	T4	26000	16000	(5)	6500	6200	6000	5800	5600	4900	3500
SB-234 & SB-274	GS11A	T6	38000	35000	(5)	9500	9200	9000	8500	7200	5600	4000
		T6 Welded	24000*	...		6000	5900	5700	5400	5000	4200	3200
Forgings												
SB-247	GS11A	T6	38000	35000	(5)	9500	9200	9000	8500	7200	5600	4000
		T6 Welded	24000*	...		6000	5900	5700	5400	5000	4200	3200

* Strength of full-section tensile specimen required to qualify welding procedures. See Par. QN-6.

ASME NEWS

With Notes on the Engineering Profession

Engineer and World of Commerce and Industry—ASME Diamond Jubilee Annual Meeting Theme

ASME Annual Meeting to Highlight 75th Anniversary Celebration. The Congress, Conrad Hilton, and Sheraton-Blackstone Hotels, Chicago, Ill., November 13–18

PLANS to date for the ASME Diamond Jubilee Annual Meeting indicate a most enjoyable program for all who will attend. In addition to the excellent technical sessions and various inspection trips there will be many featured events to make this an outstanding meeting.

The registration desk, located in the Hotel Congress, will open at 2:00 p.m., Sunday, November 13. An "Early Bird" Party, arranged by the ASME Chicago Section, will follow at 4:00 p.m., which will include refreshments, snacks, and music. For those who wish to continue the festivities, a large block of good tables has been reserved in the Boulevard Room of the Conrad Hilton for dinner and the ice show.

The President's Luncheon on Monday will pay tribute to the retiring members of the Council as well as an address by President David W. R. Morgan.

The ASME Chicago Section, host Section for the meeting, has planned a Diamond Jubilee Social Hour, Dinner, and Pageant on Tuesday evening, November 15. The pageant, in the form of a cavalcade, will be professionally produced with a cast of 25. It will consist of a lighthearted, chronological journey interweaving interesting material concerning the Society's history with correlated high lights from the field of entertainment. A narrator and special musical background will tie together some eight episodes which relate to each decade of the ASME. All seating will be assigned for the dinner.

The Annual Members and Students Luncheon as well as the Towne Lecture will be the outstanding events on Wednesday, November 16.

Thursday, November 17, will be devoted entirely to the 75th Anniversary Celebration. In the morning, a special panel will take up "The Economic Aspects of Technology." The Honors Luncheon will follow at which five of the joint engineering awards will be presented. In the afternoon another panel will discuss the theme of the meeting, "The Engineer and the World of Commerce and Industry." Thursday evening will climax the entire 75th Anniversary Year celebration with the Diamond Jubilee Social Hour, Banquet, President's Reception, and Ball. The banquet is designated as the occasion when past-presidents as well as distinguished guests of the Society will be honored. Following the banquet will be the reception and the crowning feature of the week, the Diamond Jubilee Ball.

The program for Friday, among several other important sessions, lists a nuclear-engineering panel session summarizing the "Atoms for Peace" Conference held at Geneva in August, which will be followed by the Nuclear Engineering Luncheon.

National Junior Committee

The National Junior Committee is conducting a program of interest to the Associate Members at the Diamond Jubilee Annual Meeting. The high light of this program is the evening meeting which is to be held on Monday, November 14, at 8:00 p.m. Dean A. A. Potter of Purdue University, past-president and Hon. Mem. ASME, is to discuss how engineering profits commerce and industry.

For several years the Old Guard has given moral and financial support to the activities of the National Junior Committee. The Committee is making a special point of inviting the members of the Old Guard and all other members of the Society to attend the Monday evening meeting. This would be an excellent opportunity for you to meet some of the younger men of the Society and observe the Junior Committee program to which the Old Guard have so graciously given their support.

College Reunions

Many members of the Society who attend the Annual Meeting avail themselves of the opportunity of joining their classmates and other engineers from their respective Alma Mater for mutual reminiscence and pleasure.

To date the list of reunions to be held this year in Chicago is as follows: University of California, Carnegie Institute of Technology, Clarkson College of Technology, Cornell University, Iowa State College of Agriculture and Mechanic Arts, University of Kentucky, Louisiana State University, Michigan College of Mining and Technology, Michigan State College, Ohio State University, Pratt Institute, Rensselaer Polytechnic Institute, University of Texas, Washington University, University of Wisconsin, and Worcester Polytechnic Institute.

In most instances, these reunions will be held on Wednesday, November 16.

Upon registering it is suggested that the members who are interested in joining any of the afore-mentioned groups, or forming another for his own school, consult the ASME Staff Member at the College Reunion Desk.

Tentative Program

The tentative technical program for the meeting is as follows:

MONDAY, NOVEMBER 14

8:00 a.m.

Registration

9:30 a.m.

Aviation (I)—IAS—SAE—Metals Engineering (I-A)

History of the Heavy-Press Program[1]

Where Are We Now—And Where Are We Going?[1]

9:30 a.m.

American Rocket Society (I-A)

Thermodynamics and Heat Transfer

High-Capacity Turbojet-Powered Heat Exchanger,[2] by *J. H. Schmidt*, Marquardt Aircraft Co. (Paper No. ARS—244-55)

[1] Papers not available—see box on page 932.
[2] ARS papers may be obtained by writing to Mrs. A. C. Slade, Secretary, American Rocket Society, 500 Fifth Avenue, New York, N. Y.

Forced Convective Heat-Transfer and Pressure-Drop Characteristics of White and Red Fuming Nitric Acids—Problems With Scale Formation,[2] by *H. Wolf, F. L. Gray,* and *B. A. Reese,* Purdue University (Paper No. ARS—255-55)

Heat-Transfer Characteristics of a Rocket Motor Burning White Fuming Nitric Acid and Jet-Engine Fuel at High-Combustion Pressures,[2] by *D. E. Robison, D. G. Elliott,* and *C. F. Warner,* Purdue University (Paper No. ARS—256-55)

9:30 a.m.

American Rocket Society (I-B)

Rocket Systems Stability

Mathematical Analysis of the Sensitivity of a Propellant Feed System to Rocket-Induced Vibration,[2] by *C. M. Ablow.* Stanford Research Institute (Paper No. ARS—251-55)

Measurement of the Sensitivity of a Propellant Feed System to Rocket-Induced Vibration,[2] by *E. M. Gardiner,* Boeing Airplane Co. (Paper No. ARS—252-55)

Electronic Analog Simulator Study of a Bipropellant Liquid-Rocket System,[2] by *G. G. Setterlund,* Boeing Airplane Co. (Paper No. ARS—253-55)

A Theory of Rocket-Combustion Dynamics Including Effects of Combustion-Chamber Gas Temperature,[2] by *L. Steg,* Cornell University (Paper No. ARS—254-55)

9:30 a.m.

Applied Mechanics (I)

The Solution of Multiple-Branch Piping-Flexibility Problems by Tensor Analysis, by *J. W. Soule,* United Engineers & Constructors, Inc. (Paper No. 55—A-83)

Tensor-Flexibility Analysis of Pipe-Supporting Systems, by *J. W. Soule,* United Engineers & Constructors, Inc. (Paper No. 55—A-82)

Pretwisted Beams and Columns, by *John Zickel,* General Electric Co. (Paper No. 55—A-28)

Nonlinear Bending of Circular Rods, by *H. D. Conway,* Cornell University (Paper No. 55—A-24)

Bending and Torsion of Circular Cylinder Cantilever Beams of Cylindrically Aeolotropic Material, by *W. S. Ericksen,* USAF Institute of Technology, Wright-Patterson Air Force Base, Ohio (Paper No. 55—A-41)

[2] ARS papers may be obtained by writing to Mrs. A. C. Slade, Secretary, American Rocket Society, 500 Fifth Avenue, New York, N. Y.

9:30 a.m.

Fluid Meters (I)

Review of the Pitot Tube[1]

A Practical Pulsation Threshold for Flow Meters[1]

Pulsation Errors in Manometer Gages, by *T. J. Williams,* University College of Swansea, Swansea, Wales (Paper No. 55—A-92)

9:30 a.m.

Hydraulic (I)

Panel Discussion: Current and Future Problems

Hydraulic Prime Movers: *Arthur T. Larned,* Ebasco Services, Inc.
Water Hammer: *S. Logan Kerr,* S. Logan Kerr & Co., Inc.
Pumping Machinery: *Ralph M. Watson,* Syracuse University
Cavitation: *Robert T. Knapp,* California Institute of Technology
Compressors: *Howard Emmons,* Harvard University

9:30 a.m.

Instruments and Regulators (I)

Terminology of Process-Control Valves, by *W. D. Washburn,* Allied Chemical & Dye Corp., and *Russell Milham,* Foxboro Instrument Co. (Paper No. 55—A-91)

Practical Limitations of Current Materials and Design of Control Valves, by *H. H. Gorrie,* Bailey Meter Co., and *W. L. Gantz,* American Viscose Corp. (Paper No. 55—A-113)

Control-Valve Plug Design, by *J. A. Wiedmann,* A. W. Cash Co., and *William J. Rowan,* Minneapolis-Honeywell Regulator Co. (Paper No. 55—A-103)

Procedures for Evaluation of Control-Valve Mechanical Characteristics, by *J. T. Ward,* E. I. du Pont de Nemours & Co., Inc., and *Otto Kneisel,* Hammel-Dahl Co. (Paper No. 55—A-105)

[1] Papers not available—see box on page 932.

Official Notice

ASME Business Meeting

The Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday afternoon, Nov. 14, 1955, at 4:45 p.m., The Congress Hotel, Chicago, Ill., as part of the Diamond Jubilee Annual Meeting of the Society. Members are urged to attend.

9:30 a.m.

Heat Transfer (I)

Laminar Free-Convection Heat Transfer From Outer Surface of a Vertical Cylinder, by *E. M. Sparrow* and *J. L. Gregg,* National Advisory Committee for Aeronautics (Paper No. 55—A-25)

Combined Forced and Free Laminar Heat Transfer in Vertical Tubes With Uniform Internal-Heat Generation, by *T. M. Hallmann,* National Advisory Committee for Aeronautics (Paper No. 55—A-73)

Free-Convection Heat Transfer From a Horizontal Right Circular Cylinder to Freon—12 Near the Critical State, by *R. M. Drake,* General Electric Co., and *D. L. Doughty,* Shell Development Co. (Paper No. 55—A-100)

9:30 a.m.

Machine Design (I)—Metals Engineering (I-B)

Effect of Range of Stress in Combined Bending and Torsion Fatigue Tests of 25S-T6 Aluminum Alloy, by *W. N. Findley,* Brown University, *W. I. Mitchell,* Boeing Airplane Co., and *D. D. Strohbeck,* Aberdeen Proving Ground (Paper No. 55—A-68)

The Influence of Shank Area on the Tensile Impact Strength of Bolts, by *John Love, Jr.,*

Looking up Michigan Avenue, Chicago, Ill., one sees the Conrad Hilton, Sheraton-Blackstone, and Congress Hotels, among other prominent buildings, where the ASME Diamond Jubilee Annual Meeting will be held, November 13–18

General Electric Co., and *O. A. Pringle*, University of Missouri (Paper No. 55—A-77)

9:30 a.m.

Fuels (I)

Ash Fouling

Ash Deposits on Boiler Surfaces From Burning Central Illinois Coal, by *J. R. Michel*, Commonwealth Edison Co., and *L. S. Wilcoxson*, The Babcock & Wilcox Co. (Paper No. 55—A-95)

The Sintering Test, an Index to Ash-Fouling Tendency[1]

External Boiler Deposits—A Progress Report on the Manner of Formation[1]

9:30 a.m.

Safety

Safety in Retrospect[1]

Noise, a Problem of Physical and Human Engineering[1]

Health and Safety Problems in the Nuclear-Energy Field[1]

9:30 a.m.

Boiler-Feedwater Studies

Stress Corrosion Cracking of Type-347 Stainless Steel by Treated Boiler Water[1]

Metal Transport in Liquid-Water Systems and Effect on Heat Transfer[1]

9:30 a.m.

Power (I)

Turbine Supervisory Control, by *J. C. Spahr* and *R. L. Richards*, Westinghouse Electric Corp. (Paper No. 55—A-62)

Factors Influencing the Dynamic Behavior of Tall Smoke Stacks Under the Action of the Wind, by *M. S. Ozker* and *J. O. Smith*, Detroit Edison Co. (Paper No. 55—A-69)

Design of a Large Coal-Fired Steam Generator for 200 F Exit-Gas Temperature and Operating Experience With Pilot Plant, by *W. L. Wingert* and *R. J. Stanley*, Detroit Edison Co. (Paper No. 55—A-143)

9:30 a.m.

Production Engineering (I)

Foundry Automation

Foundry Automation and the Shell-Molding Process[1]

Making Shell Molds With Automatic Machines[1]

12:15 p.m.

President's Luncheon

Toastmaster: *Lewis K. Sillcox*, Past-President and Hon. Mem. ASME
Speaker: *David W. R. Morgan*, President and Fellow ASME

2:30 p.m.

Aviation (II)

Air Cargo

Air Freight—A Blueprint for 1965, by *J. C. Emery*, Emery Air Freight Corp. (Paper No. 55—A-86)

Panel Members

W. A. Patterson, United Airlines
Robert Aldrich, Airport Operators Council of the U. S.
C. C. Hurd, International Business Machines Corp.
R. L. Winn, Wright-Patterson Air Force Base
Dudley Barrett, Buick, Oldsmobile, Pontiac Co.

2:30 p.m.

American Rocket Society (II-A)

Combustion

2:30 p.m.

American Rocket Society (II-B) Materials and Design

2:30 p.m.

Applied Mechanics (II)

On the Torsion of Rectangular Sandwich Plates, by *Paul Seide*, Ramo-Wooldridge Corp. (Paper No. 55—A-40)

On Some Problems in the Bending of Thick Circular Plates on an Elastic Foundation, by *Daniel Frederick*, Virginia Polytechnic Institute (Paper No. 55—A-36)

Large Deflections of Elliptical Plates, by *N. A. Weil*, M. W. Kellogg Co., and *N. M. Newmark*, University of Illinois (Paper No. 55—A-2)

Asymmetrical Bending of a Cylindrically Aeolotropic Tapered Disk, by *E. S. Baclig* and *H. D. Conway*, Cornell University (Paper No. 55—A-20)

Theoretical Determination of Rigidity Properties of Orthogonally Stiffened Plates, by *Norris J. Huffington, Jr.*, Virginia Polytechnic Institute (Paper No. 55—A-12)

2:30 p.m.

Fluid Meters (II)

Importance of Geometric Similarity in Flow Measurement at Extremely Low Reynolds Numbers[1]

Review of Flow-Measurement Standardization Experience in International Standards[1]

2:30 p.m.

Hydraulic (II)

Hydraulic Prime Movers

Field-Test Performance of the Reversible Pump-Turbine at Flatiron Power and Pumping Plant, by *Frank E. Jaski*, Allis-Chalmers Manufacturing Co. (Paper No. 55—A-29)

Hydraulic Turbine-Runner Vibration, by *R. M. Donaldson*, Newport News Shipbuilding & Dry Dock Co. (Paper No. 55—A-130)

2:30 p.m.

Instruments and Regulators (II)

Test Procedures for the Evaluation of Control-Valve Flow Performance, by *C. M. Johnson*, Fisher Governor Co., and *J. M. Fallis*, Standard Oil Co. of Indiana (Paper No. 55—A-152)

Effects of Adjacent Piping Configurations on Control-Valve Characteristic and Capacity, by *Glenn F. Brockett*, Fisher Governor Co., and *W. J. Kennedy*, Stone & Webster Engineering Corp. (Paper No. 55—A-138)

Procedures for Evaluating Dynamic Characteristics of Valve Operators, by *Andrew Bremer*, Shell Development Co. (Paper No. 55—A-110)

Use of Nonlinear Valve Characteristics in the Control of a Simple Blending Process, by *J. Lowen Shearer*, Massachusetts Institute of Technology (Paper No. 55—A-70)

2:30 p.m.

Heat Transfer (II)

Seal Leakage in the Rotary Regenerator and Its Effect on Rotary-Regenerator Design for Gas Turbines, by *D. B. Harper*, Aluminum Company of Canada, Ltd., Montreal, Can. (Paper No. 55—A-109)

Cooling of Glass Molds, by *R. L. Wille*, Hermann Foettinger Institute, Technical University, West Berlin, Germany (Paper No. 55—A-65)

Mass-Transfer Cooling in a Laminar Boundary Layer With Constant-Fluid Properties, by *J. P. Hartnett* and *E. R. G. Eckert*, University of Minnesota (Paper No. 55—A-108)

2:30 p.m.

Machine Design (II)—Power (II-A)

Design Improvements in Industrial Electrical Motors and Controls, by *Tom Turner* and *Clarence Lynn*, Westinghouse Electric Corp. (Paper No. 55—A-93)

Progress in Electric Power Generation, by *J. B. McClure* and *A. G. Mellor*, General Electric Co. (Paper No. 55—A-98)

2:30 p.m.

Fuels (II)

Upgrading Burner Performance of Distillate Fuel Oils by Hydrogen Treatment[1]

Improvement of Distillate Fuels by Additives and Refining Techniques[1]

Combustion Calculations[1]

2:30 p.m.

Wood Industries (I)

Panel Discussion: Methods Currently Used for Manufacturing Wood-Particle Board

Moderator: *A. J. Hall*, U. S. Forest Products Lab.

Panel Members

Dawson Zaug, Dixie Chipboard Co.
John M. Crafton, Chipcraft Co.
Don Collins, Adamson United Co.
Roy Sides, Miller-Hofft Co.
George I. Fischer, U. S. Plywood Co.
Arthur Mottet, Long-Bell Lumber Co.

2:30 p.m.

Education—Junior (I)—Management (I)

Evaluating and Developing Creative Talent at the AC Spark-Plug Division[1]

The Creative Engineer[1]

2:30 p.m.

Power (II-B)

Plant Management and Other Factors Affecting Maintenance Costs in Steam-Generating Stations, by *V. F. Estcourt*, Pacific Gas & Electric Co. (Paper No. 55—A-87)

Management of Power-Plant Maintenance[1]

Maintenance Factors Affecting Production Costs, by *C. W. Watson* and *W. F. Oberhuber*, Philadelphia Electric Co. (Paper No. 55—A-128)

2:30 p.m.

Production Engineering (II)

Machining Automation

4:00 p.m.

Tea Dance

4:45 p.m.

Business Meeting

6:00 p.m.

Wood Industries Dinner

Speaker: *A. K. Lahti*, College of Architecture and Design, University of Michigan
Subject: **Design and New Materials**

6:30 p.m.

Hydraulic Old Timers' Dinner

8:00 p.m.

Applied Mechanics (III)

Effect of an Acoustic Medium on the Dynamic Buckling of Plates, by *F. L. DiMaggio*, Columbia University (Paper No. 55—A-35)

Orders for Technical Papers

Only copies of *numbered* ASME papers will be available October 1. Some of these papers may not be available in time to permit your receiving them in advance of the meeting. Your order will be mailed only when the complete order can be filled unless you request that all papers available ten days before the meeting be mailed at that time. Please order only by paper *number;* otherwise the order will be returned. The final listing of available technical papers will be found in the issue of Mechanical Engineering containing an account of the meeting.

Copies of ASME papers may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons, or coupons which may be purchased from the Society. The coupons in lots of ten, are $2 for members; $4 for nonmembers.

Copies of unnumbered papers, listed in the program, *are not available* because the review of these manuscripts had not been completed when the program went to press. The author's name and paper number will appear with paper title in the final program (final program available only at meeting) as well as the issue of Mechanical Engineering containing an account of the meeting, if the paper has been recommended for publication in pamphlet form.

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[1] Papers not available—see box on this page.

Buckling of Simply Supported Plates Tapered in Planform, by *Bertram Klein,* University of California (Paper No. 55—A-39)

Theory of Plastic Buckling of Plates and Application to Simply Supported Plates Subjected to Bending or Eccentric Compression in Their Plane, by *P. P. Bijlaard,* Cornell University (Paper No. 55—A-8)

Creep Stresses and Deflections of Columns, by *T. H. Lin,* University of California (Paper No. 55—A-43)

Bending Creep and Its Application to Beam Columns, by *Ling-Wen Hu,* Pennsylvania State University, and *N. H. Triner,* Sandia Corp. (Paper No. 55—A-21)

8:00 p.m.

Junior (II)

Speaker: *A. A. Potter,* Purdue University
Subject: **The Young Engineer in Industry and Commerce**
Speaker: *A. J. Snider, 3rd,* Combustion Engineering, Inc.
Subject: **The Tyro Engineer—The First Ten Years**

8:00 p.m.

Instruments and Regulators (III)

Some Hydrodynamic Aspects of Valves, by *F. F. Ehrich,* Westinghouse Electric Corp.; presently, Westinghouse Resident Representative, Rolls Royce, Ltd., Derby, England (Paper No. 55—A-114)

Motion Picture: **Flow of Water in a Glass Pipe**
Commentator: *Paul Mohn,* University of Buffalo

Panel Members:

Andrew Bremer	*Otto Kneisel*
Glenn F. Brockett	*Russell Milham*
J. M. Fallis	*Paul Mohn*
W. L. Gants	*William J. Rowan*
Harvard H. Gorrie	*J. Lowen Shearer*
John Hrones	*J. T. Ward*
C. M. Johnson	*W. D. Washburn*
W. J. L. Kennedy	*John A. Wiedmann*

8:00 p.m.

Production Engineering (III)—Machine Design (III)

Panel Discussion: How To Train Engineers for Manufacturing

Frank T. Lewis, General Electric Co.
W. W. Burton, Minnesota Mining & Manufacturing Co.
R. T. Weiser, General Motors Corp.

8:00 p.m.

Fuels (III)—Gas Turbine Power (I)

Economics of the Production of Pipe-Line Gas From Coal[1]

A Preliminary Study of the Flow Characteristics of Aerated Fine Coals, by *C. H. Marks, J. I. Yellott,* and *P. R. Broadley,* Bituminous Coal Research, Inc. (Paper No. 55—A-118)

Pulsating, Pressure-Generating Combustion Systems for Gas Turbines, by *F. H. Reynst,* Sèvres (Seine-et-Oise), France (Paper No. 55—A-56)

8:00 p.m.

Wood Industries (II)

Machinery Used in the Manufacture of Wood-Shaving Boards in Germany[1]

Wood-Particle Board—A Contemporary Material[1]

8:00 p.m.

Metals Engineering (II)

Effect of Surface Finish on the Fatigue Strength of Titanium Alloys RC 130B and Ti 140A[1]

Certain Departures From Plastic Ideality at Small Strains, by *H. A. Lequear* and *J. D. Lubahn,* General Electric Research Lab. (Paper No. 55—A-151)

8:00 p.m.

High-Temperature Steam Generation—Power (III)

Experimental Superheater for Steam at 2000 Psi and 1250 F—Report After 14,281 Hours of Operation, by *J. H. Hoke* and *F. Eberle,* The Babcock & Wilcox Co. (Paper No. 55—A-102)

Evaluation of the Prototype Unit for the ASME High-Temperature Steam-Generation Investigation, by *Bela Ronay* and *W. E. Clautice,* U. S. Naval Engineering Experiment Station, and *W. F. Erskine,* ASME Research Committee on High-Temperature Steam Generation (Paper No. 55—A-63)

High-Temperature Corrosion of Alloys Exposed in the Superheater of an Oil-Fired Boiler[1]

TUESDAY, NOVEMBER 15

8:00 a.m.

Registration

9:30 a.m.

American Rocket Society (III-A)

Solid Propellants

Some Effects of Weapons Concept on Rocket Design,[2] by *H. M. Kindsvater,* Lockheed Aircraft Corp. (Paper No. ARS—257-55)

NIKE I Power-Plant Development,[2] by *R. B. Canright,* Douglas Aircraft Co. (Paper No. ARS—258-55)

A Quasi-Morphological Approach to the Geometrical Design Aspects of Propellant Charges,[2] by *J. M. Vogel,* Ramo-Wooldridge Corp. (Paper No. ARS—259-55)

Observations on the Irregular Reaction of Solid Propellant Charges,[2] by *Leon Green,* Aerojet-General Corp. (Paper No. ARS—260-55)

A film will be shown on **Criteria and Service Conditions Resulting in USAF Solid Propellant Rocket-Engine Specification Requirements,** prepared by the Power Plant Lab., Wright Air Development Center, and narrated by *W. C. Fagan* of the Power Plant Lab.

9:30 a.m.

American Rocket Society (III-B)

Aerodynamics

9:30 a.m.

Applied Mechanics (IV)

Studies on Plastic Flow of Anisotropic Materials, by *Ling-Wen Hu,* Pennsylvania State University (Paper No. 55—A-79)

A Theory of the Yield Point and the Transition Temperature of Mild Steel, by *Frederick Forscher,* Westinghouse Electric Corp. (Paper No. 55—A-42)

Combined Stress Tests in Plasticity, by *Aris Phillips,* Yale University, and *Lloyd Kaechele,* Stanford University (Paper No. 55—A-15)

Comparison of Slip-Line Solutions With Experiment, by *E. G. Thomsen,* University of California (Paper No. 55—A-51)

Analysis of Creep in Rotating Disks Based on the Tresca Criterion and Associated Flow Rule, by *A. M. Wahl,* Westinghouse Research Labs. (Paper No. 55—A-46)

9:30 a.m.

Gas Turbine Power (II-A)—Oil & Gas Power (I-A)

Some Design Aspects of the Free-Piston Gas-Generator Turbine Plant—Part 1, Thermodynamics and Component Characteristics, by *W. A. Morain,* The Cooper-Bessemer Corp., and *S. L. Soo,* Princeton University (Paper No. 55—A-146)

Some Design Aspects of the Free-Piston Gas-Generator Turbine Plant—Part 2, Controls, Accessories, Instrumentation, and Design Components[1]

[1] Papers not available—see box on page 932.
[2] ARS papers may be obtained by writing to Mrs. A. C. Slade, Secretary, American Rocket Society, 500 Fifth Avenue, New York, N. Y.

Registration Schedule

Sunday, November 13, 2:00 p.m. to 5:00 p.m.
Monday, November 14, 8:00 a.m. to 8:00 p.m.
Tuesday, November 15, 8:00 a.m. to 3:00 p.m.
Wednesday, November 16, 8:00 a.m. to 8:00 p.m.
Thursday, November 17, 8:00 a.m. to 3:00 p.m.
Friday, November 18, 8:00 a.m. to 3:00 p.m.

The Supercharged and Intercooled Free-Piston and Turbine-Compound Engine, by *A. L. London,* Stanford University (Paper No. 55—A-147)

9:30 a.m.

Hydraulic (III-A)—ASCE (I)—AWWA (I)

Third Symposium on Water Hammer—Part 1

Report of Committee on Water Hammer[1]

Water-Column Separation in Pump-Discharge Lines, by *R. T. Richards,* Ebasco Services, Inc. (Paper No. 55—A-74)

Hydraulic Transients in Centrifugal-Pump Systems, by *C. P. Kittredge,* Princeton University (Paper No. 55—A-72)

9:30 a.m.

Hydraulic (III-B)—Gas Turbine Power (II-B)

Compressors

Closed Systems for Testing Compressors[1]

The Slotted-Blade Axial-Flow Blower[1]

9:30 a.m.

Management (II)

Panel Discussion: The Engineer in Our World—Utilizing Engineering Skills

Use of Men—Trained and Untrained: *John Gammell,* Allis-Chalmers Manufacturing Co.
Use of Women: *Dot Merrill,* Merrill & Co.
Use of Machines: *Paul E. Eisele,* Warner & Swasey Co.

9:30 a.m.

Production Engineering (IV-A)

Operations Research

Research Problems in Production Routing and Scheduling, by *A. J. Rowe* and *J. R. Jackson,* University of California (Paper No. 55—A-148)

Rational Bases for Automation[1]

9:30 a.m.

Mechanical-Pressure Elements (I)

Design of Corrugated Diaphragms, *J. A. Haringx,* N. V. Philips, Gloeilampenfabrieken, Eindhoven, Holland (Paper No. 55—A-112)

Corrugated-Metal-Diaphragm Performance, by *A. V. Kankel* and *D. C. Whitten,* The Bristol Co. (Paper No. 55—A-115)

Bibliography on Diaphragms and Aneroids[3]

9:30 a.m.

Heat Transfer (III)—Power (IV-A)

The New Zealand Thermal Area and Its Development for Power Production, *C. J. Banwell,* Dominion Physical Lab. (Private Bag), Lower Hutt, New Zealand (Paper No. 55—A-58)

Flow Sampling and Discharge Measurement in Geothermal Bores, by *C. J. Banwell,* Dominion Physical Lab., (Private Bag), Lower Hutt, New Zealand (Paper No. 55—A-97)

Motion pictures and a general discussion of problems in the New Zealand thermal area will be presented by *O. P. Bergelin,* University of Delaware

9:30 a.m.

Machine Design (IV)—Oil and Gas Power (I-B)—Railroad (I)—Lubrication Activity (I)—Metal Processing (I)—Production Engineering (IV-B)

Mechanization on the Farm, by *A. E. W. Johnson,* International Harvester Co. (Paper 55—A-99)

The Diesel-Engine's Progress and Future, by *B. W. Wadman* and *Mark Ogden, Diesel Progress* (Paper No. 55—A-94)

The Pursuit of Happiness, by *A. V. Bodine,* The Bodine Corp. (Paper No. 55—A-96)

9:30 a.m.

Power (IV-B)—Metals Engineering (III)

Materials Failure—Part 1

Report of the Investigation of the Turbine-Wheel Fracture at Tanners Creek[1]

Investigation of Large Steam-Turbine-Spindle Failure[1]

Report of the Investigation of Two Generator-Rotor Fractures[1]

[3] Presented by title only.

9:30 a.m.

Instruments and Regulators (IV)

Hydraulic-Power Steering—Effects of Valve Characteristics and Steering-Wheel Inertia, by *W. E. McCarthy* and *W. A. VanWicklin,* Ford Motor Co. (Paper No. 55—A-64)

Sonic Pneumatic Measurements of Lengths and Their Applications, by *A. L. A. Fortier,* Fluid Mechanics Lab., University of Paris, Clamart/Seine, France (Paper No. 55—A-111)

Design Basis for Multiloop-Positional Servomechanisms, by *Sidney Lees,* Massachusetts Institute of Technology (Paper No. 55—A-126)

Vortex-Tube Free-Air Thermometry, by *L. S. Packer* and *H. C. Box,* Cornell Aeronautical Lab., Inc. (Paper No. 55—A-22)

12:15 p.m.

Management Luncheon

Toastmaster: *J. Keith Louden,* vice-president and general manager, York Corp.
Speaker: *Glenn B. Warren,* vice-president and general manager, General Electric Co.
Subject: **Current Trends in Top Managements,** by *Glenn B. Warren* and *Harold F. Smiddy,* vice-president, Management Consultation Services, General Electric Co.

12:15 p.m.

Heat Transfer Luncheon

Toastmaster: *H. B. Nottage,* chairman, ASME Heat Transfer Division; project manager, Propulsion Research Corp.
Speaker: *H. S. Olsen,* director of personnel and industrial relations, Minneapolis-Honeywell Regulator Co.
Subject: **A Jubilee Message—Attaining Professional Stature**

12:15 p.m.

Applied Mechanics Luncheon

2:30 p.m.

American Rocket Society (IV-A)

Liquid Propellants

Test Methods for Mono Propellants,[2] by *P. F. Winternitz,* New York University (Paper No. ARS—236-55)

Storability of Nitric Acid,[2] by *D. M. Mason,* Jet Propulsion Lab. (Paper No. ARS—237-55)

Properties of Ozone,[2] by *G. M. Platz,* Armour Research Foundation (Paper No. ARS—238-55)

Rocket-Performance Measurements With Streak Photography,[2] by *M. F. Heidmann* and *C. M. Auble,* NACA, Lewis Flight Propulsion Lab. (Paper No. ARS—239-55)

Optimum Ratio of Propellants for a Liquid Bi-Propellant Rocket System Operating Within a Mixture Ratio Tolerance,[2] by *Joseph Biousseau,* Boeing Airplane Co. (Paper No. ARS—240-55)

2:30 p.m.

American Rocket Society (IV-B)

Control Systems

2:30 p.m.

American Rocket Society (IV-C)

High-Altitude Research

2:30 p.m.

Applied Mechanics (V-A)

Plastic Deformation of Semi-Infinite Beam Subject to Transverse Impact Loading at the Free End, by *Margaret F. Conroy,* Boston College (Paper No. 55—A-49)

The Load-Carrying Capacity of Circular Plates at Large Deflection, by *E. T. Onat* and *R. M. Haythornthwaite,* Brown University (Paper No. 55—A-14)

The Pattern of Plastic Deformation in a Deeply Notched Bar With Semicircular Roots, by *L. Garr, E. H. Lee,* Brown University, and *A. J. Wang,* Illinois Institute of Technology (Paper No. 55—A-23)

Plastic Twisting of Thick-Walled Circular-Ring Sectors, by *Walter Freiberger* and *William Prager,* Brown University (Paper No. 55—A-85)

On the Ideally Plastic Indentation of Inset-Rectangular Bands, by *E. W. Ross, Jr.,* Watertown Arsenal Lab. (Paper No. 55—A-52)

[2] ARS papers may be obtained by writing to Mrs. A. C. Slade, Secretary, American Rocket Society, 500 Fifth Avenue, New York, N. Y.

2:30 p.m.

Gas Turbine Power (III)

The Thermodynamics of Cooled Turbines, Part 1—The Turbine Stage[1]

The Thermodynamics of Cooled Turbines, Part 2—The Multistage Turbine[1]

Effect of Turbine-Blade Cooling on Efficiency of a Simple Gas-Turbine Power Plant, by *W. M. Rohsenow,* Massachusetts Institute of Technology (Paper No. 55—A-120)

Analysis of the Effect of Blade Cooling on Gas-Turbine Performance[1]

2:30 p.m.

Hydraulic (IV)—ASCE (II)—AWWA (II)

Third Symposium on Water Hammer—Part 2

Surge-Wave Velocity—Concrete Pipe, by *H. F. Kennison,* Lock Joint Pipe Co. (Paper No. 55—A-75)

Water-Hammer Calculations and Test Results—Owens Gorge Power Plant Penstocks, by *A. E. Bratfisch* and *Kenneth O. Cartwright,* Department of Water and Power, City of Los Angeles (Paper No. 55—A-71)

2:30 p.m.

Management (III)

Panel Discussion: Ethics in Engineering Management

Management's Responsibility to the Engineer[1]

The Engineer's Responsibility to Its Management[1]

The Engineer and the Customer[1]

2:30 p.m.

Production Engineering (V)

Pressed-Metal Automation

A Basic Approach to Progressive Mechanization[1]

Special Machines—Their Design and Use in a Small-Parts Plant[1]

2:30 p.m.

Mechanical-Pressure Elements (II)

Investigation of the Properties of Corrugated Diaphragms[1]

Recent Research on Flat Diaphragms and Circular Plates With Particular Reference to Instrument Applications, by *A. M. Wahl,* Westinghouse Research Labs. (Paper No. 55—A-116)

2:30 p.m.

Oil and Gas Power (II)

A Rational Approach to Crankshaft Design, by *C. M. Lowell,* Worthington Corp. (Paper No. 55—A-57)

Panel Discussion: Philosophy of Diesel-Engine Ratings

Moderator: *L. N. Rowley,* McGraw-Hill Publishing Co.
Vice-Chairman: *S. E. Miller,* American Bosch Corp.

Panel Members

H. Wade Barth, General Motors Corp.
R. L. Boyer, Cooper-Bessemer Corp.
E. L. Dahlund, Fairbanks, Morse & Co.
P. S. Vaughan, American Locomotive Co.

2:30 p.m.

Heat Transfer (IV)

Solution of Transient Heat-Transfer Problems by the Resistance-Network Analog Method, by *G. Liebmann,* Associated Electrical Industries, Ltd., Berkshire, England (Paper No. 55—A-61)

Experimental Study of the Temperature Distribution in Plates During Arc Welding, by *G. A. Hawkins* and *R. J. Grosh,* Purdue University (Paper No. 55—A-26)

An Investigation of Convective Heat Transfer in a Porous Medium, by *S. M. Marco* and *L. S. Han,* Ohio State University (Paper No. 55—A-104)

2:30 p.m.

Machine Design (V)—Metals Engineering (IV-A)—Applied Mechanics (V-B)

The Springback of Metals, by *F. J. Gardiner,* I.T.E. Circuit Breaker Co. (Paper No. 55—A-66)

Selection and Application of Spring Materials, by *H. C. R. Carlson,* The Carlson Co. (Paper No. 55—A-76)

[1] Papers not available—see box on page 932.

2:30 p.m.

Power (V)—Metals Engineering (IV-B)

Materials Failure—Part 2

Large Rotor Forgings for Turbines and Generators[1]

Acceptance Guides for Ultrasonic Inspection of Large Rotor Forgings[1]

The Work of the ASTM Task Forces on Hydrogen and on Brittle Fracture of Large Forgings[1]

2:30 p.m.

Railroad (II)

Report of Committee RR-6—Progress in Railroad Mechanical Engineering 1954–1955[1]

Adhesion—How Much? by *F. G. Fisher,* Reading Railway Co., and *R. K. Allen,* General Electric Co. (Paper No. 55—A-132)

Service Testing of Freight Cars, by *O. C. Maier,* Pullman-Standard Car Manufacturing Co. (Paper No. 55—A-139)

6:00 p.m.

Social Hour

6:30 p.m.

Diamond Jubilee Dinner and Pageant

WEDNESDAY, NOVEMBER 16

8:00 a.m.

Registration

9:00 a.m.

Railroad (III)

History and Development of ACF-Talgo, by *J. R. Furrer,* ACF Industries (Paper No. 55—A-131)

Practical Considerations in New Railway Passenger-Car Design, by *A. G. Dean,* The Budd Co. (Paper No. 55—A-134)

Pullman-Standards, Train X, by *T. C. Gray,* Pullman-Standard Car Manufacturing Co. (Paper No. 55—A-140)

The General Motors Lightweight Train[1]

9:30 a.m.

American Rocket Society (V-A)

Space Medicine

Climatization of Animal Capsules for Upper-Stratosphere Balloon Flights,[2] by *D. G. Simons,* Holloman Air Development Center (Paper No. ARS—241-55)

The Medical Problems Involved in Orbital Space Flight,[2] by *Hubertus Strughold,* USAF School of Aviation Medicine (Paper No. ARS—242-55)

9:30 a.m.

American Rocket Society (V-B)

Instrumentation and Testing

The Turbojet-Exhauster Story,[2] by *T. E. Hudson,* Marquardt Aircraft Co. (Paper No. ARS—245-55)

Marquardt Jet Lab High-Speed Instrumentation System,[2] by *P. D. Bayless,* Marquardt Aircraft Co. (Paper No. ARS—246-55)

Method of High-Frequency Liquid-Flow Measurement,[2] by *Kurt Stehling,* Bell Aircraft Co. (Paper No. ARS—247-55)

Shock Tube for Gage Performance Study,[2] by *A. E. Wolf,* California Institute of Technology (Paper No. ARS—248-55)

Analytical Study of Frequency Response of Pressure Transducer Systems,[2] by *A. G. Presson,* California Institute of Technology (Paper No. ARS—249-55)

Statistical Analysis of Instrumentation for Rocket-Engine Research Testing,[2] by *J. M. Zimmerman,* North American Aviation, Inc. (Paper No. ARS—250-55)

9:30 a.m.

Applied Mechanics (VI)

Stiffness of Curved Circular Tubes With Internal Pressure, by *P. G. Kafka* and *M. B. Dunn,* Boeing Airplane Co. (Paper No. 55—A-32)

Displacements in an Elastic-Plastic Shell, by *P. G. Hodge, Jr.,* Polytechnic Institute of Brooklyn (Paper No. 55—A-4)

Analysis of Short Thin Axisymmetrical Shells Under Axisymmetrical Edge Loading, by *G. Horvay, C. E. Linkous,* and *Mrs. J. S. Born,* General Electric Co. (Paper No. 55—A-3)

On Axially-Symmetric Bending of Nearly Cylindrical Shells of Revolution, by *R. A. Clark,* Case Institute of Technology, and *E. Reissner,* Massa-

chusetts Institute of Technology (Paper No. 55—A-18)

A Study of Axisymmetric Vibrations of Cylindrical Shells as Affected by Rotatory Inertia and Transverse Shear, by *T. C. Lin* and *G. W. Morgan*, Brown University (Paper No. 55—A-59)

9:30 a.m.

Gas Turbine Power (IV-A)

Transient Temperature and Thermal Stress in Locomotive Gas-Turbine Buckets[1]

Correlation of Fir-Tree-Type Turbine-Blade Fastening Strength With Mechanical Properties of Materials, by *A. G. Holms* and *A. J. Repko*, NACA, Lewis Flight Propulsion Lab. (Paper No. 55—A-122)

9:30 a.m.

Hydraulic (V)

Pumping Machinery—Cavitation

Thermodynamic Aspects of Cavitation in Centrifugal Pumps, by *A. J. Stepanoff* and *H. A. Stahl*, Ingersoll-Rand Co. (Paper No. 55—A-136)

Turbulence and Boundary-Layer Effects on Cavitation Inception From Gas Nuclei, by *J. W. Daily*, Massachusetts Institute of Technology, and *V. E. Johnson*, National Advisory Committee for Aeronautics (Paper No. 55—A-142)

Critical Considerations on Cavitation Limits of Centrifugal and Axial-Flow Pumps, by *G. F. Wislicenus*, Pennsylvania State University (Paper No. 55—A-144)

9:30 a.m.

Heat Transfer (V)—Gas Turbine Power (IV-B)

Combined-Force and Free-Convection Heat Transfer in a Horizontal Pipe, by *J. J. Martin*, Bendix Aviation Corp., and *M. B. Carmichael*, Esso Standard Oil Co. (Paper No. 55—A-30)

Heat-Transfer Coefficients for Air and Carbon Dioxide, by *E. L. Katz*, Convair (Paper No. 55—A-101)

Engineering Relations for Heat Transfer and Friction in High-Velocity Laminar and Turbulent Boundary-Layer Flow Over Surfaces With Constant Pressure and Temperature, by *E. R. G. Eckert*, University of Minnesota (Paper No. 55—A-31)

Turbulent Flow and Heat Transfer on a Flat Plate at High Mach Numbers With Variable Fluid Properties, by *R. G. Deissler* and *A. L. Loeffler, Jr.*, NACA, Lewis Flight Propulsion Lab. (Paper No. 55—A-133)

The Viscosity of Steam, Heavy-Water Vapor, and Argon at Atmospheric Pressure Up to High Temperature, by *C. F. Bonilla*, Columbia University; *S. J. Wang*, Air Products, Inc.; and *H. Weiner*, U. S. Army, Camp Detrick, Md. (Paper No. 55—A-6)

9:30 a.m.

Power (VI)

Status of Demineralizing for Treatment of Boiler Feedwater in Today's Power Plants[1]

A System of Charging for Steam in Industrial Plants With Power Generation, by *L. J. Sforzini* and *Claude A. Winslow, Jr.*, Eastman Kodak Co. (Paper No. 55—A-54)

Fluid Flow Through Two Orifices in Series-III—The Parameters of Stable and Metastable Flow of Hot Water at Higher Pressures[1]

A Planned Turbine-Testing Program, by *F. H. Light*, Philadelphia Electric Co. (Paper No. 55—A-53)

9:30 a.m.

Production Engineering (VI)—Metals Engineering (V-A)

Use of Universal Automatic Computers in Production Engineering

Computers and Production Engineering[1]

Design and Application of the Carboloy Machinability Computer[1]

9:30 a.m.

Metals Engineering (V-B)

On the Applicability of Notch-Tensile-Test Data to Strength Criteria in Engineering Design, by *J. D. Lubahn*, General Electric Research Lab. (Paper No. 55—A-149)

Application of Materials-Property-Test Data to Design[1]

Creep Damage in a Cr-Mo-V Steel as Measured by Retained Stress-Rupture Properties[1]

[1] Papers not available—see box on page 932.

9:30 a.m.

Rubber and Plastics (I)

Use of Rubber in Home and Industry—Past, Present, Future[1]

Use of Rubber in Transportation—Past, Present, Future[1]

Rubber-Review Paper 1955[1]

9:30 a.m.

Materials Handling (I)

Pneumatic Conveying as Adapted by the Milling Industry[1]

The Mechanization Profile—A Tool for Measuring Automation[1]

Some Basic Concepts Relating Material-Handling Costs to Over-All Production Costs[1]

9:30 a.m.

Machine Design (VI)

Dynamics of Instrument Bearing-Torque Testing[1]

Design Study of a Hydrostatic Gas Bearing With Inherent Orifice Compensation[1]

Load Ratings for Miniature Ball Bearings, by *T. S. Kauppinen*, University of New Hampshire, and *R. H. Carter*, Miniature Precision Bearings, Inc. (Paper No. 55—A-117)

12:15 p.m.

Consulting Engineers Luncheon

12:15 p.m.

Railroad Luncheon

12:15 p.m.

Members and Students Luncheon

2:30 p.m.

American Rocket Society (VI)

Space-Flight Symposium

2:30 p.m.

Applied Mechanics (VII)—AAAS (I)

Stress Functions for Rotating Plates, by *P. G. Hodge, Jr.*, Polytechnic Institute of Brooklyn (Paper No. 55—A-5)

Stress Concentration Caused by Multiple Punches and Cracks, by *Michael Sadowsky*, Rensselaer Polytechnic Institute (Paper No. 55—A-16)

General Solutions of the Equations of Elasticity and Consolidation for a Porous Material, by *M. A. Biot*, Shell Development Co. (Paper No. 55—A-7)

Propagation of a Sudden Rotary Disturbance in an Elastic Plate in Plane Stress, by *J. N. Goodier*, Stanford University, and *W. E. Jahsman*, General Electric Co. (Paper No. 55—A-47)

High-Frequency Extensional Vibrations of Plates, by *T. R. Kane*, University of Pennsylvania, and *R. D. Mindlin*, Columbia University (Paper No. 55—A-50)

A Method for Calculating Stress-Concentration Factors,[3] by *M. Hetenyi*, Northwestern University, and *D. T.-Y. Liu*, California Research Corp. (Paper No. 55—A-81)

Stress Distribution in a Strip Loaded in Tension by Means of a Central Pin,[3] by *Pericles S. Theocaris*, Shell Petroleum Co. (HELLAS) Ltd., Athens, Greece (Paper No. 55—A-34)

2:30 p.m.

Gas Turbine Power (V)

Tests of an Experimental Coal-Burning Turbine[1]

The Filtration of No. 6 Fuel Oil to Remove Undesirable Trace Metals, by *C. A. Shields, Jr.*, General Electric Co. (Paper No. 55—A-121)

2:30 p.m.

Hydraulic (VI)

Pumping Machinery—Cavitation

Some Aspects of High-Suction Specific-Speed Pump Inducers, by *C. C. Ross* and *G. Banerian*, Aerojet-General Corp. (Paper No. 55—A-124)

The Design of Axial-Flow Pumps, by *R. D. Bowerman*, California Institute of Technology (Paper No. 55—A-127)

Suppression of Machine Vibration Set Up When Starting Up Pump Operation, by *F. Numachi*, Institute of High Speed Mechanics, Tohuku University (to be presented by *R. T. Knapp*, California Institute of Technology) (Paper No. 55—A-145)

[3] Presented by title only.

2:30 p.m.

Heat Transfer (VI)

Mean-Temperature Difference in One, Two, and Three-Pass Crossflow Heat Exchangers—Part 1, Counter Current Exchangers, by *R. A. Stevens* and *J. R. Woolf*, Convair (Paper No. 55—A-90)

Mean-Temperature Difference in One, Two, and Three-Pass Crossflow Heat Exchangers—Part 2, Cocurrent Exchangers, by *J. Fernandez* and *J. R. Woolf*, Convair (Paper No. 55—A-89)

Temperature and Velocity Distribution in Turbulent Flow of Mercury, by *B. H. Amstead, H. E. Brown*, and *B. E. Short*, University of Texas (Paper No. 55—A-107)

The Transfer of Heat and Momentum in a Turbulent Stream of Mercury, by *H. E. Brown, B. H. Amstead*, and *B. E. Short*, University of Texas (Paper No. 55—A-106)

Convection Phenomena in Fluids Heated From Below, by *Simon Ostrach*, NACA, Lewis Flight Propulsion Lab. (Paper No. 55—A-88)

2:30 p.m.

Consulting Engineering

Professional Problems Involved in Submitting Contracts for Engineering Work[1]

The Component Parts That Make Up Engineering Costs[1]

2:30 p.m.

Metal Processing (II)

New Research Techniques in Metal Cutting[1]

Heat Transfer to and Temperature Distribution in a Metal-Cutting Tool[1]

An Analysis of the Orthogonal Boring Operation, by *B. W. Shaffer*, New York University (Paper No. 55—A-67)

2:30 p.m.

Metals Engineering (VI)—Rubber and Plastics (II-A)

The Development of Cermets as Structural Materials[1]

Plastics as Mechanical-Engineering Materials[1]

Experiences in Production-Vacuum Melting of Nickel-Base Alloys[1]

2:30 p.m.

Rubber and Plastics (II-B)

The Rubber and Plastics Engineers in Science and Industry

Education: *Webster N. Jones*, Carnegie Institute of Technology

Research: *F. E. Reese*, Monsanto Chemical Co.

Production: To be announced

Sales: *Donald L. Gibb*, Dow Chemical Co.

2:30 p.m.

Furnace-Performance Factors—Corrosion and Deposits From Combustion Gases—Power (VII)

Evaluation of Factors Affecting Heat Transfer in Furnaces[1]

Fly-Ash Refining at South Charleston Plant of Carbide and Carbon Chemical Company[1]

The Work of the Central Electricity Authority (Britain) on the Fouling and Corrosion of Boiler Plant, by *H. E. Crossley*, Central Electricity Authority, London, England (Paper No. 55—A-153)

2:30 p.m.

Materials Handling (II)

More Movement—Less Investment—More Profit[1]

Recognition of Materials Handling in Its Entirety for Proper Evaluation[1]

5:00 p.m.

Towne Lecture

Speaker: *Crosby Field*, president, Flakice Corp.

Subject: **The Greatest Achievement of the Engineer in Commerce and Industry**

5:30 p.m.

Consulting Engineers Social Hour

7:00 p.m.

American Rocket Society Honors Dinner

8:00 p.m.

Power (VIII)

First Commercial Supercritical-Pressure Steam-Electric Generating Unit for Philo Plant, by

S. N. Fiala, American Gas & Electric Service Corp. (Paper No. 55—A-137)

First Commercial Supercritical-Pressure Steam Generator for Philo Plant, by *W. H. Rowand* and *A. M. Frendberg*, The Babcock & Wilcox Co. (Paper No. 55—A-135)

First Commercial Supercritical-Pressure Steam Turbine for Philo Plant[1]

8:00 p.m.

Metal Processing (III)

Some Studies of Angle Relationships in Metal Cutting, by *J. H. Creveling, T. F. Jordan*, and *E. G. Thomsen*, University of California (Paper No. 55—A-125)

On the Drilling of Metals—The Torque and Thrust in Drilling[1]

8:00 p.m.

Metals Engineering (VII)

Bending and Impact Tests of Cast-Iron, Cast-Steel, and Nodular-Iron Valve Bodies, by *J. O. Jeffrey*, Cornell University, and *R. H. Hanlon*, The Kennedy Valve Manufacturing Co. (Paper No. 55—A-10)

The Use of Nodular Iron in Electrical Switchgear, by *F. E. Florschutz*, Westinghouse Electric Corp. (Paper No. 55—A-150)

8:00 p.m.

Rubber and Plastics (III)

Use of Plastics in Home and Industry—Past, Present, Future[1]

Use of Plastics in Transportation—Past, Present, Future[1]

Plastics-Review Paper 1955[1]

8:00 p.m.

Applied Mechanics (VIII)

Bending Vibrations of Variable-Section Beams, by *E. T. Cranch*, Cornell University, and *A. A. Adler*, Cornell Aeronautical Lab., Inc. (Paper No. 55—A-19)

Effect of Hub Radius on the Vibrations of a Uniform Bar, by *W. E. Boyce*, Brown University (Paper No. 55—A-44)

Slip Damping of Turbine-Blade Vibrations, by *L. E. Goodman* and *J. H. Klumpp*, University of Minnesota (Paper No. 55—A-80)

A Matrix Solution for the Vibration Modes of Nonuniform Disks, by *F. F. Ehrich*, Westinghouse Electric Corp.; presently, Westinghouse Resident Representative, Rolls Royce, Ltd., Derby, England (Paper No. 55—A-17)

Determination of Natural Frequencies of Continuous Plates Hinged Along Two Opposite Edges, by *A. S. Veletsos* and *N. M. Newmark*, University of Illinois (Paper No. 55—A-11)

Flexural Vibrations of Rectangular Plates,[2] by *R. D. Mindlin*, Columbia University, *A. Schacknow*, Republic Aviation Corp., and *Herbert Deresiewicz*, Columbia University (Paper No. 55—A-78)

8:00 p.m.

Materials Handling (III)

Air-Freight Analysis—United Airlines Cargo-Handling System[1]

The Selection of a Fork Truck for General Use in the Building Industry[1]

The Homemaker, Grocery Shopping, and Materials Handling[1]

Materials-Handling Analysis—Southern Plant—National Lead Company[1]

THURSDAY, NOVEMBER 17

8:00 a.m.

Registration

9:30 a.m.

75th Anniversary Convocation

Presentation of Greetings:
Industrial Societies
Trade Associations

10:00 a.m.

75th Anniversary Panel (I)

The Economic Aspects of Technology

Panel Members

James H. Doolittle, vice-president, Shell Oil Co.

Simes T. Hoyt, staff consultant, Castle & Cooke, Ltd., Honolulu, Hawaii

Carl G. A. Rosen, consulting engineer, Caterpillar Tractor Co.

Clyde E. Williams, director, Battelle Memorial Institute

12:15 p.m.

Joint Honors Luncheon

Presentation of Awards

John Fritz Medal (Est. 1902) to *Philip Sporn*, president, American Gas & Electric Services Corp., New York, N. Y.
Daniel Guggenheim Medal (Est. 1928) to *Theodore von Karman*, chairman, NATO Advisory Group for Research & Development, Palais de Chaillot, Paris, France
Henry Gantt Gold Medal (Est. 1929) to *Walker L. Cisler*, president, Detroit Edison Co., Detroit, Mich.
Hoover Medal (Est. 1930) to *Charles F. Kettering*, director, General Motors Corp., Detroit, Mich.
Elmer A. Sperry Award (Est. 1955) to *William Francis Gibbs*, president, Gibbs & Cox, Inc., New York, N. Y.

2:30 p.m.

75th Anniversary Panel (II)

The Engineer and the World of Commerce and Industry

Philip Sporn, president, American Gas & Electric Services Corp., New York, N. Y.
Charles F. Kettering, director, General Motors Corp., Detroit, Mich.
Walker L. Cisler, president, Detroit Edison Co., Detroit, Mich.
William Francis Gibbs, president, Gibbs & Cox, Inc., New York, N. Y.

6:00 p.m.

Social Hour

7:00 p.m.

Banquet

FRIDAY, NOVEMBER 18

8:00 a.m.

Registration

9:30 a.m.

Applied Mechanics (IX)

A Method of Stepwise Integration in Problems of Impact Buckling, by *A. F. Schmitt*, Ryan Aeronautical Co. (Paper No. 55—A-37)

Studies in Dynamic Photoelasticity, by *M. M. Frocht* and *P. D. Flynn*, Illinois Institute of Technology (Paper No. 55—A-1)

Free Convective Thermal and Mass Transfer From a Vertical Flat Plate, by *E. V. Somers*, Westinghouse Research Labs. (Paper No. 55—A-48)

Critical Thickness of Surface Film in Boundary Lubrication, by *I-Ming Feng*, Bendix Aviation Corp., and *C. M. Chang*, Massachusetts Institute of Technology (Paper No. 55—A-84)

Some Dynamic Properties of Oil-Film Journal Bearings With Reference to the Unbalance Vibration of Rotors, by *A. C. Hagg* and *G. O. Sankey*, Westinghouse Research Labs. (Paper No. 55—A-45)

9:30 a.m.

Heat Transfer (VII)

Panel Discussion: Industrial Sources and Needs for Thermophysical Data

Thermophysical Properties of Sodium and NaK[1]

Factors of Importance Regarding Thermodynamic Properties of Combustion Products in Jet-Propulsion Systems[1]

Transport Properties of Gases at Very High Temperatures[1]

The Availability of Thermophysical Data at Present, Methods of Evaluating Their Accuracy, New Formulas for Estimating These Values, and the New MCA Physical Data Project[1]

Properties of Refrigerants[1]

Auxiliary Publications and Other Sources of Obscure Data[1]

9:30 a.m.

Petroleum

A Review of Mechanical-Engineering Progress in the Petroleum Industry[1]

A Look Into the Future of Mechanical Engineering in the Petroleum Industry, by *E. W. Jacobson*, Gulf Research & Development Co. (Paper No. 55—A-119)

9:30 a.m.

Power Test Codes

Symposium on Evaluation of Test Accuracy

Instrumentation for Steam-Consumption Tests on Medium Steam-Turbine-Generator Sets[1]

Procedures for Testing Steam-Turbine-Generators in Central Stations[1]

A Practical Application of Uncertainty Calculations to Measured Data[1]

9:30 a.m.

Metal Processing (IV)

Influence of Grinding Fluids Upon Residual Stresses in Hardened Steel, by *H. R. Letner*, University of Pittsburgh (Paper No. 55—A-123)

Residual Stresses in Cold-Extruded Aluminum, by *J. Frisch* and *E. G. Thomsen*, University of California (Paper No. 55—A-27)

9:30 a.m.

Process Industries (I)

The Effect of Product Characteristics on the Selection of a Continuous-Type Drier[1]

Application of Superheated-Vapor Atmospheres to Drying[1]

9:30 a.m.

Lubrication Activity (II)

9:30 a.m.

Nuclear Engineering (I)—Power (IX)

Panel Session Summarizing AEC Invitation Conference at Geneva, August, 1955

12:15 p.m.

Nuclear Engineering Luncheon

Toastmasters: *A. C. Pasini*, chairman, ASME Nuclear Engineering Division, 1955; Detroit Edison Co., Detroit, Mich., and *T. A. Solberg*, chairman, Nuclear Engineering Division, 1956; Rear Admiral, USN(Ret.), consultant, Washington, D. C.
Speaker: *Charles L. Huston, Jr.*, president, Lukens Steel Co., Coatesville, Pa.
Subject: **The Role of Steel in Nuclear Engineering**

2:30 p.m.

Applied Mechanics (X)—AAAS (II)

Momentum Diffusion From a Slot Jet Into a Moving Secondary, by *A. S. Weinstein, J. F. Osterle*, and *Walton Forstall*, Carnegie Institute of Technology (Paper No. 55—A-60)

On the Wake Energy of Moving Cascades, by *N. H. Kemp*, United Aircraft Corp., and *W. R. Sears*, Cornell University (Paper No. 55—A-33)

A Suction Device Using Air Under Pressure, by *L. F. Welanetz*, Fairchild Camera & Instrument Corp. (Paper No. 55—A-38)

Unsteady Radial Flow of Gas Through Porous Media: Variable Viscosity and Compressibility, by *J. S. Aronofsky*, Magnolia Petroleum Co., and *J. D. Porter*, Monsanto Chemical Co. (Paper No. 55—A-13)

The Effect of the Earth's Rotation on Laminar Flow in Pipes, by *G. S. Benton*, The Johns Hopkins University (Paper No. 55—A-9)

2:30 p.m.

Heat Transfer (VIII)

Graphical Methods for the Temperature Response of Bodies in a Varying-Temperature Medium, by *Fred Landis*, New York University, and *J. O. Tearnen*, Ryan Aeronautical Co. (Paper No. 55—A-141)

The Air-Cooled Electronic Chassis, by *M. Mark* and *M. Stephenson*, Raytheon Manufacturing Co. (Paper No. 55—A-55)

High-Speed Guarded Hot-Plate Apparatus for Thermal Conductivity of Thermal Insulation, by *E. V. Somers*, Westinghouse Electric Corp. (Paper No. 55—A-129)

Liquid-Droplet Heating and Evaporation in a High-Temperature Gas Stream, by *J. W. Rizika*, Massachusetts Institute of Technology (Paper No. 55—A-154)

2:30 p.m.

Power (X)—Nuclear Engineering (II)

Performance of a Once-Through Steam Generator Using a Liquid-Metal Heat Source[1]

[2] Presented by title only.

[1] Papers not available—see box on page 932.

Aqueous-Homogeneous Reactors for Producing Central-Station Power[1]

Dresden Nuclear Power Station—Preliminary Design and Economics[2]

2:30 p.m.

Metal Processing (V)

Panel Discussion: Plastic Working of Metals

2:30 p.m.

Process Industries (II)

Combating Corrosion With a Glass Coating[1]

Industrial Applications of Ceramics[1]

2:30 p.m.

Effect of Temperature on the Properties of Metals—Metals Engineering (VII)

Properties of Cast Iron at Elevated Temperatures[1]

Validity of Time-Compensated Temperature Parameters for Correlating Creep and Creep-Rupture Data[1]

Mechanical Properties at Elevated Temperatures of Ductile Cast Iron[1]

Structural Stability of Modified 12-Chromium Alloys[1]

Inspection Trips

Tues., Nov. 15—Tour of R. R. Donnelly & Son Co.

Wed., Nov. 16—Tour of the Ridgeland Generating Station of the Commonwealth Edison Co.

Fri., Nov. 18—Trip to the Museum of Science and Industry, including tour of German Submarine U-505.

WOMEN'S PROGRAM

Sunday, November 13

4:00 p.m.	Cocktail Party—with men of ASME, Congress Hotel, Meetings Headquarters
7:00 p.m.	Dinner and Ice Show, Boulevard Room, Hilton Hotel

Monday, November 14

12:15 p.m.	President's Lucheon—will join men at their luncheon, Gold Room, Congress Hotel, Meetings Headquarters
4:00 p.m.	Tea Dance, Congress Hotel

Tuesday, November 15

8:00 a.m.	National Board Breakfast and Meeting
10:00 a.m.	Tour to Museum of Science and Industry including tour of U-505, only submarine captured in action in World War II. Also, tour of internationally famous Colleen Moore's Doll House, with lecture by Colleen Moore herself. Personally conducted tour. (See exquisite furnishings; real gems used in interiors.)
1:00 p.m.	Annual Luncheon—South Shore Country Club. Guest of Honor: *Ivy Baker Priest*, Treasurer of the United States. Very charming and witty speaker.
6:00 p.m.	Jubilee Night Dinner—with men. Preceded by Cocktail Party. Grand Ballroom, Hilton Hotel

Wednesday, November 16

10:00 a.m.	Annual Business Meeting of the Auxiliary
11:15 a.m.	Tour to Board of Trade—largest wheat pit in world. See trading on floor.
3:00 p.m.	Fur Fashion Show and Tea. Pump Room, Ambassador East Hotel

Thursday, November 17

9:30 a.m.	Tour of North Shore—lecture at Baha'i Temple, Wilmette, architectural wonder.
12:00 noon	Luncheon at Kungsholm Restaurant, followed by famous miniature opera "Il Trovatore," only one of its kind in America
6:00 p.m.	Cocktail Party—Normandy Lounge
7:00 p.m.	Banquet—Grand Ballroom, Hilton Hotel

An especially designed and valuable 75th Anniversary memento for the ladies. Also numerous and valuable door prizes at each of women's events. Specially chartered buses will be supplied for all conducted tours.

Coffee will be served each morning by the Hostess Committee in the Presidential Suite of the Congress Hotel, which will be headquarters for the women. Punch will be served in the afternoon. Hostesses will be on duty at the headquarters at all times to see that all "visiting" ladies become acquainted.

[1] Papers not available—see box on page 932.

[2] Presented by title only.

ASME Calendar of Coming Events

Oct. 10–12
ASME-ASLE Second Lubrication Conference, Antlers Hotel, Indianapolis, Ind.
(Final date for submitting papers was June 1, 1955)

Oct. 19–20
ASME-AIME Joint Fuels Conference, Neil House, Columbus, Ohio
(Final date for submitting papers was June 1, 1955)

Nov. 13–18
ASME Diamond Jubilee Annual Meeting, Hotel Congress, Chicago, Ill.
(Final date for submitting papers was July 1, 1955)

Nov. 14–18
Exposition of Power and Mechanical Engineering, as part of ASME 75th Anniversary Annual Meeting, Coliseum, Chicago, Ill.
(For Meetings of Other Societies, see page 942)

Exhibits Raise Tempo of ASME Chicago Power Show, November 14–18

Current information concerning exhibits at the Chicago Exposition of Power and Mechanical Engineering has raised the tempo of that display to a new level, with promise of even more innovations than had been anticipated. The exposition, to be held November 14 to 18 at the Chicago Coliseum, will be under the auspices of The American Society of Mechanical Engineers, whose Diamond Jubilee Annual Meeting, during the same week, climaxes this year's celebration of the Society's 75th year.

Atomic Power Section

Strong interest has been drawn to the display by the inclusion of an Atomic Power Section, a new feature, supporting a program of technical papers to be offered at the meeting by the ASME Nuclear Energy Division. Exhibits in this group of displays are expected to afford answers to many questions regarding applications of mechanical engineering in the practical uses of atomic energy. Such applications are already seen to embrace many new devices and modifications of existing equipment, to meet the specific requirements of a new school of design.

The specific requirements of nuclear engineering, as distinguished from conventional applications of mechanical design, are already seen to lie in the fields of shielding and remote control, automation, and new developments in instrumentation. A great deal of invention has already been developed along these lines, but how much of it will be ready for disclosure when the exposition opens will depend on a tight schedule in completing display material. All of it will be very new.

Power-Plant and Mechanical Equipment

Equipment to meet the expanding needs of conventional design of power plants and mechanical equipment is well advanced and promises a well-rounded exposition. The trends, as far as they may be discerned in advance of the opening date, continue along the lines of demand for extreme operating conditions in pressures, temperatures, and flow rates. The movement toward intensification of loads, with the stiffer resistances required to combat corrosion and wear, continues unabated. Its principal impact is felt in the fields of structural materials, in which producers continue their bold advance, while manufacturers of equipment incorporate into new designs improved materials as fast as they are offered.

A manufacturer of industrial insulations for high temperatures down to subzero will offer a new line of pipe coverings, block, sheet, and formed, for temperatures from boiling water up to 1600 F. The new formula is a combination of special inorganic silicates and asbestos fibers. It is said to show no deterioration after exposure to high-moisture conditions, while its thermal conductivity and strength actually improve after operating at high temperatures. It is available in sectional and segmental blocks, and may be nested where extreme protection is required.

Valves

Typical of improvements such as have been made in a number of different lines in valve designs is one new and complete line of general-purpose gate, globe, and angle valves. These valves feature Stellited seat rings, integral seat globe valves, and stainless-steel angle valves. Another exhibitor of valves, controls, and flow tubes is offering control valves having an "isoforce" actuator, or one having an equal force output throughout its entire stroke. This is embodied in valve bodies designed to satisfy the strictest specifications in the industry. The new feature allows use of a smaller actuator with wider application and more sensitive control by the main valve.

Motor-Speed Controls

The principal features of still another exhibit include a line of motor-speed controls of simple design which can be adapted for either rapid or slow starting; second, a line of stroboscopes; third, a series of noise-measuring instruments for analyzing noise in factories—among other uses—for the purpose of determining whether a risk of hearing impairment exists; and fourth, a high-rating voltage regulator, offering high-

speed response (20 volts per second) and unusual accuracy.

"The world's most compact power package," is the manufacturer's characterization of the latest modification of a form of steam generator that is widely used on diesel locomotives for supplying high-pressure steam to heat long trains. The new adaptation of that highly efficient design has been developed for industrial applications, either in single or multiple-unit installations. It is especially suitable for applications where demand is intermittent, but exacting. For such purposes seven sizes of completely automatic units are available in 18 to 160-hp ratings, or equivalent steaming capacity, from and at 212 F, from 620 to 5520 pounds per hour. Fuel, combustion air, feedwater, and forced draft are interlocked to vary the output over a wide range in response to changing steam demand. The boiler is fired with oil, gas, or with a combination, quick change-over burner. A highly efficient heat release is assured by the method of injecting the fuel downward into the pressurized combustion chamber. Water enters the outer coils of the tubular nest and passes through progressively larger coils into zones of increasingly high temperature, emerging as 80 to 90 per cent steam, the remainder carrying scale-forming sludge over to the separator. Any change in steam-line pressure causes a corresponding change in feedwater volume. The result of this closely integrated control system and tubular-boiler construction is a unit that develops full-steam pressure in two minutes from a cold start.

1955 ASME Air-Pollution Congress Papers Published in New Book

The proceedings of the First International Congress on Air Pollution, held in March, 1955, by The American Society of Mechanical Engineers (see Mechanical Engineering, April, 1955, pages 376–378) are presented in a new book entitled "Problems and Control of Air Pollution."

Edited by F. S. Mallette, executive secretary, Committee on Air-Pollution Controls, ASME, and published by Reinhold Publishing Corporation, New York, N. Y., the book's 280 pages are crammed with up-to-the-minute information for scientists, engineers, municipal officials, and the like.

The authors whose papers appear in this work are among the world's foremost authorities in the field of air-pollution control.

No effort has been spared to include the newest, most authoritative material available. This is particularly true of the chapters on the treatment and recovery of sulphur dioxide—widely recognized as one of the most formidable challenges to effective air-pollution control.

Fully described are the present gaps in our knowledge of air pollution and the need for further research in many directions. Of particular interest to research groups in this country is the chapter on "The Growth of Public Opinion," by Sir Hugh E. C. Beaver, Hon. Mem. ASME, which summarizes the British smog problem and the remedies proposed. Another high light of the book is the chapter on "Management Aspects of Air Pollution," by G. Edward Pendray, Mem. ASME, which tells how to avoid pitfalls in community relations over air-pollution problems.

"Problems and Control of Air Pollution" will prove of immense interest and value to everyone concerned with reducing or eliminating air contamination. Management and technical personnel of any industry interested in the control of sulphur gases from the burning of fuels or from processing operations will especially welcome the chapters on treatment and recovery of sulphur dioxide. Civic groups, municipal officials, and those concerned with the medical, biological, and meteorological aspects of air pollution will gain many helpful ideas from the section on new developments in control and the experiences in air pollution abroad.

Copies of the book may be obtained from the ASME Order Department, 29 West 39th Street, New York, N. Y., at $7.50 a copy.

ASME Leads Off With 28 Papers at EJC Nuclear Engineering and Science Congress

A full-scale opportunity to investigate and evaluate our progress in atomic energy and its applications for peaceful, productive purposes will be possible at the Nuclear Engineering and Science Congress to be held in Cleveland, Ohio, December 12–16. The Congress is being co-ordinated by Engineers Joint Council. It is expected that more than 2000 representatives of industry, government, and education will avail themselves of this opportunity to discuss the advances in more than 50 fields of atomic engineering with members of the 25 participating national science and engineering societies, of which The American Society of Mechanical Engineers is one.

Technical Papers

The 300 papers to be presented descriptive of nuclear developments will be the heart of this technical session. The tentative program indicates that the papers will cover every major phase of progress in atomic energy from uranium ore deposits to the new use of radioactive isotopes and from reactors to insurance. Many of these papers were declassified by the AEC to permit presentation at the Congress.

Moreover, these presentations and the overall panorama of the Congress will provide the first real opportunity for the general public to understand the massive impact of atomic energy on our economy. Nuclear energy and its products are already used by over 3000 industrial firms in the United States. Though impressive, this is but a small part of the potential application. This is demonstrated by the tremendous range of interest of participants in the Congress. The sponsoring groups co-ordinated in this effort by the Engineers Joint Council and its constituent societies involve half-a-million engineers and scientists representing such apparently diverse fields as mining, metallurgy, sanitation, water supply, radio, electronics, chemical, petroleum, steel, nonferrous metals, aviation, automobile manufacture, rockets, architecture, ships, road construction, and city planning.

Atomic Exposition

Running concurrently with the Congress and supplementing its discussions of nuclear developments will be an Atomic Exposition to display the current actual tools of atomic-development reactors, components, equipment, materials, and services in the atomic-power field. This Exposition, sponsored by the American Institute of Chemical Engineers, will include many initial displays of nuclear equipment and will be open to the public on December 10 and 11.

Thorndike Saville, president, Engineers Joint Council, summed up the primary purposes of the Congress as follows: "The horizon for the peaceful application of atomic developments is, as yet, not even imagined. This highly interrelated family of developments is, as yet, very much in the 'idea for application' stage. Therefore it is of enormous importance to present to those interested a panoramic view with detail as a proper measure of current opportunity and the vastness of potential. Progress for the Congress already indicates that it will be the largest gathering of engineers and scientists ever held in the United States to discuss nuclear energy. As such, it will be a major opportunity for the communication of ideas and developments among the many thousands of persons in industry, business, agriculture, and medicine for whom the technology of the atom is increasingly important."

The Congress is being co-ordinated by Engineers Joint Council whose constituent societies are the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Water Works Association, American Institute of Electrical Engineers, The Society of Naval Architects and Marine Engineers, American Society For Engineering Education, The American Society of Refrigerating Engineers, American Institute of Chemical Engineers, and The American Institute of Industrial Engineers.

The co-sponsoring societies which are co-operating with Engineers Joint Council in this Congress are the American Chemical Society, American Institute of Physics, Institute of Radio Engineers, American Nuclear Society, American Geological Institute, American Society for Metals, American Rocket Society, Institute of the Aeronautical Sciences, Atomic Industrial Forum, Society of Automotive Engineers, American Society for Testing Materials.

The Cleveland hosts for the Congress are the Cleveland Engineering Society and the Cleveland Technical Societies Council.

The curator of the Engineering Division in the National Museum, played by William Morey, *right*, tells Gus, an old caretaker, played by Larry Bolton, that he must move some machine exhibits from one wing of the museum to another because of the impending visit of a group of mechanical engineers. Scene is from the new ASME 25-minute color motion picture, "To Enrich Mankind," produced by the Jam Handy Organization.

Archimedes, in the person of character-actor Gregory Morton, *left*, explains the importance of the wheel and the pulley to Gus, a skeptical, old caretaker in the National Museum, played by veteran actor Larry Bolton. This is another scene from the Jam Handy produced ASME film which was designed to show the significance of the role mechanical engineering has played in the development of our country. Script was written by Frank Murray and directed by Wally Fox.

Mechanical Engineering Given Stellar Role in ASME Film

Archimedes tells how mechanical engineers have aided world progress

To Enrich Mankind is the title of a 25-minute color motion picture just prepared for The American Society of Mechanical Engineers.

Believed to be the first such production ever sponsored by one of the major engineering societies, the film is designed "to explain to the public the significance of the role mechanical engineering plays in the development of our country."

Leading parts in the picture are played by Gregory Morton, radio, television, and screen star, who has just completed a feature assignment in the Hollywood production of "Vagabond King," and Larry Bolton, veteran actor, producer, and director. Wally Fox directed the picture for the Jam Handy Organization, producers.

The story begins in the National Museum where Gus, an old caretaker, played by Mr. Bolton, has been assigned the responsibility of setting up an exhibit of machines for a group of mechanical engineers. While he is grumbling about his chores, a statue of Archimedes, played by Mr. Morton, comes to life.

Archimedes explains that he was a mechanical engineer himself, having hit upon the principle of the lever, among other discoveries and inventions. A series of cuts shows the skeptical Gus how mechanical engineers contribute to progress by making possible such diverse objects as farm machinery, home appliances, aircraft, automobiles, railroads, ocean liners, machine tools, rockets, atomic reactors, printing presses, even ferris wheels, and bicycles.

Script for the picture was written by Frank Murray. The film is printed in Eastman Commercial Kodachrome on 16-millimeter reels. Prints of the film are available on loan, without charge, to schools, television stations, and nonprofit organizations. Interested persons should write to Barbara A. Brown, Public Relations Department, ASME, 29 West 39th St., New York 18, N.Y.

1956 Mechanical Catalog Now Being Distributed

Within a short time, every ASME member who has requested a copy will receive the new 1956 edition of Mechanical Catalog. Designed as an aid in specifying and buying functions, it contains 50,000 listings of more than 6000 products of 3500 manufacturers, plus over 300 pages of charts, photographs, and detailed drawings.

Over the years, Mechanical Catalog has become an invaluable reference volume for engineers in 21 basic industries. Constant editing of listings, industry-inspired phraseology revisions, and a continuing flow of suggestions from ASME members have helped make the Catalog the most valuable of its kind.

One important feature of the 1956 edition is a 20-page descriptive listing of all ASME publications. From this bibliography, engineers can quickly check their requirements for the latest standards and codes as well as other special data.

ASME-AIME High-Temperature Symposium at Metals Congress Announced

Wednesday, October 19, Crystal Room, Adelphia Hotel, Philadelphia, Pa.

Chairmen: *W. R. Hibbard, Jr.*, Institute of Metals Division, AIME, and *J. J. B. Rutherford*, Metals Engineering Division, ASME

9:00–10:30 a.m.

Materials for Use Up to 1250 F

Alloy Design of Material Up to 1250 F, by *A. I. Rush*, University of Michigan

Stability of AISI Alloy Steels, by *A. B. Wilder, E. F. Ketterer, and D. B. Collyer*, National Tube Division, U. S. Steel Corporation

2:00–3:00 p.m.

Some Practical Aspects of High-Temperature Design Below 1250 F, by *E. C. Chapman*, Combustion-Engineering

3:00–5:00 p.m.

Materials for Use Above 1250 F

Principles of Design and Development of Alloys for Use Above 1250 F, by *N. J. Grant*, Massachusetts Institute of Technology

Over Six-Million Flying Hours Later, by *A. W. F. Green*, General Motors Corporation

People . . .

Honors and Awards. Theodore von Karman, Mem. ASME, Chairman, NATO Advisory Group for Aeronautical Research and Development, Paris, France, has been awarded the Daniel Guggenheim Medal for 1955. Formal presentation will be made at the Honors Luncheon to be held during the ASME Diamond Jubilee Annual Meeting in Chicago, Ill., Nov. 13–18.

David A. Huffman, assistant professor of electrical engineering, the Massachusetts Institute of Technology, will be awarded the Louis E. Levy Medal of The Franklin Institute of the State of Pennsylvania. The award, for a paper of especial merit, will be presented at the Institute's annual Medal Day ceremonies, Wednesday, October 19. Some of the other awards to be presented on that day include the following: F. P. Bowden, reader in physical chemistry, University of Cambridge, England, is to be recipient of the Elliott Cresson Medal for discovery or original research; and Cecil Waller, chief emulsion chemist, Ilford Limited, and Robert Berriman, Kodak Limited, both of England, will receive the Edward Longstreth Medals for their investigation in, and contribution to, the development of photographic emulsions especially designed for the study of nuclear particles and events, which have made possible important new advances in this field, including the discovery of new nuclear particles and a better understanding of cosmic rays.

Charles S. Leopold, consulting engineer, Philadelphia, Pa., will be recipient of a Frank P. Brown Medal for his outstanding contribution to air conditioning, particularly in the research and development of air-conditioning techniques and the application of air conditioning to a wide variety of important structures.

Clarence A. Kemper of Franklin, La., an honor graduate at M.I.T., has been awarded the Barium Steel Corporation Fellowship for graduate study in mechanical engineering at the Institute during the year 1955–1956. He has been an active participant in the ASME Student Branch affairs.

During the weeks of July 11 and 18, ISO/TC11—Unification of Boiler Codes held meetings with eight delegates from Europe to prepare a Draft Proposal of an international boiler code. The delegates were representatives of the secretariats of Subcommittees SC1—Materials for Boilers, Germany; SC2—Strength of Pressure Parts, France; SC3—Welded Construction, Holland; WG1—Properties of Boiler Materials at Elevated Temperatures, England. The code, which resulted from these meetings, is now being printed as a Draft Proposal by ASME for discussion at the next meeting of ISO/TC11 in Madrid, Spain, in February, 1956. On Saturday, July 16, the entire group went on an automobile tour of the New York metropolitan area and Connecticut. Shown in the front row on the steps of the United Nations Building, *left to right,* are: F. X. Gilg, U. S. A.; E. O. Bergman, U. S. A.; W. C. Chipperfield, England; H. C. Brown, England; W. Dorrscheid, Germany; H. Weinberger, Germany; J. D. Wilding, ASME; and Michel Hubert, France. In rear, *left to right,* are: M. Sluis, Holland; Phillipe Mercier, France; J. L. Menson, U. S. A.; and J. J. P. Cattel, Holland.

Campus News. Waldo Shumway, dean of Stevens Institute of Technology, became provost of the engineering college on September 1, according to an announcement by Jess H. Davis, Mem. ASME, Stevens president. Other promotions announced included the following: Lynn L. Merrill, head of the department of mathematics, assumed the position of dean of faculty; James H. Potter, Mem. ASME, associate dean, as dean of graduate studies; and William J. Farrisee, also an associate dean, as dean of men.

Dorrance H. Goodwin has assumed the principal administrative responsibilities of the Lowell Technological Institute Research Foundation. His appointment follows the resignation of John H. Skinkle as executive director.

Albert H. Cooper, Mem. ASME, professor of chemical engineering, University of Maryland, has been named chairman of the department of chemical engineering at Pratt Institute. Dr. Cooper is also manager of the Pilot Engineering Company and vice-president and technical director of Chemchron Corporation. Alfred Doll, Mem. ASME, acting dean, also announced the appointment of Fritz C. Wildermann as assistant professor of physics and that of Albert Goldstein as instructor in mechanical engineering.

50 Years a Woman Engineer. Lydia Gould Weld, Mem. ASME, of Carmel, Calif., was a guest of the Executive Council, Los Angeles Section of the Society of Women Engineers, in March. The occasion marked the celebration of her fifty years in engineering. Miss Weld received a BS in Marine Engineering and Naval Architecture from the Massachusetts Institute of Technology in 1903. She was the second woman to be admitted to membership in The American Society of Mechanical Engineers.

Multimillions for Merit-Scholarship Program. Walker L. Cisler, Fellow ASME, president, Detroit Edison Company, and Henry T. Heald, Mem. ASME, chancellor, New York University, were named among the members of the board of directors of the newly established National Merit Scholarship Corporation, which recently announced the largest independent college-scholarship program in the history of American education. The program went into effect in September and will provide a minimum of 350 grants for September, 1956. The initial funds exceeding $21 million have been contributed by the Ford Foundation, Carnegie Corporation, Sears-Roebuck Foundation, and Time, Inc.

Officers Elected. The newly established group, "Belgian Engineers in North America," comprising graduates of Belgian engineering schools residing in the United States, Canada, and all territories north of Panama, recently elected officers. They are: Leon G. Rucquoi, technical and economic consultant, New York, N. Y., as president; Leon A. Fraikin, president, Franki Foundation Company in New York, vice-president; and Max Lorie, general director, American Intercontinental Trade and Service Company, New York, secretary.

World Symposium on Applied Solar Energy, Solar Exhibition, and Conference on Solar Energy Designed for International Audience of Authorities

Equipment illustrating recent development in the field of solar engineering, like the engine manufactured by Societa Motori Recuperi (SOMOR) of Lecco, Italy, will be one of 35 working models on display at the Solar Engineering Exhibit in Phoenix, Ariz., from October 29 through November 13.

The device, intended to be coupled to a water pump, will be one of several solar engines shown. This SOMOR machine involves flat-plate collectors that use the sun's rays to evaporate sulphur dioxide which then operates a vapor-piston engine. The vapor is condensed by a water-cooled condenser and returned to the collectors in a continuous cycle.

Solar-Engineering Exhibit

The Solar-Engineering Exhibit will be in conjunction with the World Symposium on Applied Solar Energy meeting in Phoenix, November 1–5, at the Westward Ho Hotel. Leading authorities in the field of solar energy from the United States and abroad will present technical papers and in several instances will show models. The Symposium is expected to draw some 1000 scientists and engineers from all over the world interested in the effort to harness energy from the sun's rays. Many of the conferees will also attend the earlier Conference on Solar Energy—The Scientific Basis—October 31 and November 1, at the University of Arizona at Tucson.

Conference on Solar Energy

One of the major purposes of the conference will be to assist scientists in charting the direction of future research. The conference will permit free discussion of the scientific basis upon which the utilization of solar energy is founded. Following a general session, three sections will convene to discuss thermal, photochemical, and electrical processes for converting the sun's energy to man's use.

These events, the conference, symposium, and exhibition on solar energy, are being sponsored jointly by the Stanford Research Institute, the Association for Applied Solar Energy, and the University of Arizona.

An estimated 30,000 to 40,000 persons are expected to attend the exhibit where approximately 65 displays of equipment and other demonstrations will be set up at the Phoenix Civic Center by numerous individuals, manufacturers, and research organizations, including contributions from the Massachusetts Institute of Technology research program led by Hoyt C. Hottel, Mem. ASME. Material has also been made available by the University of Wisconsin research group headed by Farrington Daniels.

F. A. Brooks, Mem. ASME, of the department of agricultural engineering at the Agricultural Experiment Station on the University of California's Davis campus has contributed a "solaranger," a device for studying the pattern of sunlight on structures for any latitude or time of day or year. Mr. Brooks will also display several sunlight-measuring instruments, including one with a computer which delivers tabulated, typewritten reports.

Visitors to the exhibit will see a production model of a solar water-heating collector and steam generator sent to Phoenix by the Meromit, Ashkolon Metal Works, Tel Aviv, Israel.

Maria Telkes of New York University, will display her solar food-cooking oven that uses four flat-aluminum reflectors to direct the sun's rays into an oven that achieves temperatures of about 350 F. Dr. Telkes will also have a working model of a sunlight collector using newly developed absorbing surfaces. In addition, she will show solar stills that use sunlight to evaporate salt water with a cool surface to condense vapor into fresh water.

Convair Division of General Dynamics Corporation will demonstrate how a 5-ft mirror solar furnace of the high-temperature type is used in industrial work, one of several used in their materials research at San Diego, Calif.

Several examples of solar-energy conversion by electrical, chemical, and biological devices will be demonstrated.

Bell Telephone Laboratories will have a working display of a silicon solar battery operating a small motor, in addition to other demonstrations to illustrate the uses of the silicon battery and the preparation of silicon crystals for use in constructing the batteries.

Wright Air Development Center at Wright-Patterson Air Force Base, Dayton, Ohio, has made available a display to demonstrate the useful work obtainable from a cadmium-sulphide solar battery when applied to a small motor.

The sun-operated portable-radio transmitter developed by Edwin Keonjian at General Electric Company's Electronics Laboratory at Syracuse, N. Y., will be exhibited. This transmitter, about the size of a pack of cigarettes, is powered by several photoelectric cells and has a range of about 100 ft.

The various exhibits will be arranged under the following classifications: World distribution of sunlight and instruments of its measurment; sunlight collectors and absorbers; food cookers; house and water-heating methods; high-temperature furnaces; mechanical engines; agricultural aids; and miscellaneous and historical items.

Symposium Objectives

Summaries of work done and recent new findings in the major fields of solar energy will be presented by the outstanding authorities and specialists from many countries. The Symposium will bring together the research workers throughout the world and those of industry, business, and government who are interested in hastening the day of solar-energy utilization. Work sessions will give opportunity for presentation of volunteer papers and for open discussion of the details of specific phases of solar-energy capture. An exhibition of solar devices, brought from several countries, will show the present state of engineering development. From this five-day session should emerge a clearer picture of the unsolved problems, their relationships, and a program for additional research and engineering developments.

American and Canadian Aeronautical Engineers to Meet in Ottawa November 3-4

ASME members take prominent part in the activities of the meeting

The second annual joint meeting of the Institute of the Aeronautical Sciences and the Canadian Aeronautical Institute will be held November 3 and 4 in Ottawa, Ont., Can.

Nine technical papers will be presented during the two-day conference at the Chateau Laurier, which also will include a tour of Canada's National Aeronautical Establishment, the first W. Rupert Turnbull Memorial Lecture, and a dinner at which the Right Hon. C. D. Howe, Hon. Mem. ASME, Canadian Minister of Trade and Commerce, will speak.

The meeting will open Thursday morning, November 3, with a session devoted to three papers on the general subject of aircraft structures. B. J. Kaganov, chief structures engineer of Canadair Limited, Montreal, Que., will serve as chairman. The papers are: "Unique Structural Problems in Supersonic Aircraft Design," by Fred P. Mitchell, chief stress engineer, Avro Aircraft Limited, Toronto, Ont.; "Experiment and Theory in Investigating the Behavior of Structures at High Temperatures," by Nicholas J. Hoff, Mem. ASME, head of the department of aeronautical engineering and applied mechanics, Polytechnic Institute of Brooklyn; and "Optimum Structural Design of Wing Box Beams," by Saul Bernstein, group leader, stress department, Canadair Limited, Montreal, Que.

Turnbull Lecture

John H. Parkin, Mem. ASME, director of the National Aeronautical Establishment of Canada, has been chosen to deliver the Turnbull Lecture, which will take place Thursday afternoon in the hotel. Speaking on "W. Rupert Turnbull, 1870–1954," Mr. Parkin will review the pioneering work of the noted Canadian aeronautical engineer in a technical-historical light. The late Mr. Turnbull con-

structed a wind tunnel and began experiments on airplane-wing shapes in 1902. Subsequently turning his attention to propeller theory, he won the (British) Royal Aeronautical Society's Bronze Medal in 1911 and developed an electrically controlled variable-pitch propeller that was flight-tested successfully in 1927—the predecessor of reverse-pitch propellers used on modern airliners. Chairman of the lecture will be T. E. Stephenson, director of the aircraft branch, Department of Defence Production, Ottawa, Canada.

The annual dinner will be held Thursday evening in the hotel ballroom. Mr. Howe will be introduced by R. D. Richmond, president of the Canadian Aeronautical Institute.

Materials and Processes

Two simultaneous sessions are scheduled for Friday morning, November 4. One will be devoted to materials and processes (used in aircraft construction) and these three papers will be presented: Aluminum Alloys for Elevated-Temperature Service, The Metal Bonding of Assemblies for the Canadair CL-28 Maritime Reconnaissance Airplane, and Materials and Fabrication Techniques for Structural Heat-Resistant Plastic Sandwiches.

Safety Design

The other Friday morning session will be a discussion of aircraft safety design and accidents (that is, 1, designing airplanes for safe operation and, 2, methods used in investigating airplane accidents to prevent similar accidents in the future). Chairman of this session will be I. A. Gray, Assoc. Mem. ASME, director of engineering and maintenance, Canadian Pacific Airlines, Vancouver, B. C. These three papers will be delivered at the Safety session: Significant Problems in Air Safety, by Jerome Lederer, Mem. ASME, managing director of the Flight Safety Foundation, Inc. and director of the Cornell-Guggenheim Aviation Safety Center, New York City; Aircraft Accident Investigation Techniques, by Group Captain Ralph C. Davis, director of flight safety, Royal Canadian Air Force (Hq. RCAF); and Recent Results of NACA Crash-Fire Research With Jet Airplanes, by I. Irving Pinkel, associate chief of the physics division, Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio.

On Friday afternoon the delegates will be taken on a guided tour of the laboratories devoted to research in structures, high-speed aerodynamics, gas dynamics, and engines at the National Aeronautical Establishment in Ottawa, Can. They also will visit the hydraulic and ships laboratory of the National Research Council, where they will see a model of the St. Lawrence Seaway.

ASME Membership as of Aug. 31, 1955

Honorary Members	73
Fellows	409
Members	14,521
Affiliates	302
Associate Members (33 and over)	3,808
Associate Members (30–32)	4,504
Associate Members (to the age of 29)	16,672
Total	40,289

Ninth International Congress of Applied Mechanics

The Ninth International Congress for Applied Mechanics will be held in Brussels in the buildings of the "Université Libre" from Wednesday, September 5, to Thursday, September 13, 1956.

In consultation with the International Committee it has been decided to organize the technical sessions of the Congress in two sections, namely, Section 1, Fluid dynamics and aerodynamics, and Section 2, Mechanics of solids (rigid dynamics, vibrations, elasticity, plasticity).

Moreover, several general lectures are contemplated on subjects likely to be of interest to members of both sections.

It should be noted that "Thermodynamics" and "Computational Methods" as such are not included, although specific applications to pertinent problems of one of the two sections mentioned above are acceptable subjects for papers to be presented at the ninth Congress.

During the first four days of the Congress the mornings will be reserved for sessions of Section 1 and the afternoons for sessions of Section 2. In the second four days Section 2 will meet in the mornings and Section 1 in the afternoons. This arrangement will provide for adequate time for subsection or private meetings and also for the possibility to attend lectures in both sections.

In order to allow enough time for presentation and discussion, the Organizing Committee will make a selection.

According to the time available, only a certain number of papers, chosen for their general interest, will be presented before the sections.

A period of 30 minutes (20 for presentation and 10 for discussion) will be allowed for each of these papers.

The remaining papers, grouped by subjects, will be presented in subsection meetings, a period of 15 minutes being allowed to each, and at the end of every meeting a general discussion will take place.

Abstracts of papers should be submitted in three copies to the address above *before April 15, 1956*, in order to permit these abstracts to be selected and printed before the Congress. All abstracts will be included in the book of abstracts. The book will be available upon registration at the Congress at a price of 100 F.B. ($2).

The Congress fee will be 200 F.B. ($4). An extra charge of 150 F.B. ($3) will cover the banquet (including probably an excursion on September 10).

A brochure giving all information will be issued early next October; it was announced that accommodation and payments will be dealt with through the American Express Company and that special terms are now being looked into for younger members.

Meetings of Other Societies

Oct. 10–12
American Management Association, conference on automation, Hotel Roosevelt, New York, N. Y.

Oct. 14–15
The National Society of Professional Engineers, fall meeting, Peabody Hotel, Memphis, Tenn.

Oct. 17–21
American Welding Society, fall technical meeting, Bellevue-Stratford Hotel, Philadelphia, Pa.

Oct. 17–21
American Society for Metals, national metal congress and exposition, Benjamin Franklin Hotel and Convention Hall, Philadelphia, Pa.

Oct. 17–21
National Safety Council, 43rd congress and exposition, Conrad Hilton, Congress, Morrison, and La Salle Hotels, Chicago, Ill.

Oct. 19–20
American Institute of Electrical Engineers, conference on "The Application of Motors to Space Heating and Cooling Equipment," Chase Hotel, St. Louis, Mo.

Oct. 20–21
Texas Personnel and Management Association, 17th annual conference, The University of Texas, Austin, Texas

Oct. 20–22
National Council of State Boards of Engineering Examiners, 34th annual meeting, Sheraton Park Hotel, Washington, D. C.

Oct. 20–22
Institute of Management Sciences, annual conference, Park Sheraton Hotel, New York, N. Y.

Oct. 20–Nov. 3
Atomic Industrial Forum, peacetime atomic-energy exposition, Carnegie Endowment International Center, New York, N. Y.

Oct. 24–26
American Standards Association and the National Bureau of Standards, conference on standards, Sheraton Park Hotel, Washington, D. C.

Oct. 24–28
American Society of Civil Engineers, annual convention, Hotel Statler, New York, N. Y.

Oct. 25–27
Institution of Mechanical Engineers, combustion conference, London, England

Oct. 26–28
American Society of Body Engineers, annual convention, Rackham Memorial Building, Detroit, Mich.

Oct. 31–Nov. 2
National Lubricating Grease Institute, annual meeting, Edgewater Beach Hotel, Chicago, Ill.

Oct. 31–Nov. 4
Society of Automotive Engineers, Golden Anniversary transportation and diesel-engine meeting, Chase Hotel, St. Louis, Mo.

Nov. 1–3
Investment Casting Institute, fall meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

Nov. 2–4
The Society of Rheology, annual meeting, Henry Hudson Hotel, New York, N. Y.

Nov. 3–4
Society for the Advancement of Management, 11th annual conference, Hotel Statler, New York, N. Y.

Nov. 7–9
American Institute of Electrical Engineers, Institute of Radio Engineers, and Association for Computing Machinery, Eastern joint computer conference and exhibition, Hotel Statler, Boston, Mass.

Nov. 9
The Institute of Metals (London), symposium on "The Mechanism of Phase Transformations in Metals," Lecture Theatre of the Royal Institution of Great Britain, London, England

(Continued on next page)

Nov. 9–10
SAE, fuels and lubricants meeting, Bellevue-Stratford Hotel, Philadelphia, Pa.

Nov. 9–11
Industrial Management Society, 19th annual time and motion study and management clinic, Hotel Sherman, Chicago, Ill.

Nov. 9–12
The Society of Naval Architects and Marine Engineers, 63rd annual meeting, Waldorf-Astoria Hotel, New York, N. Y.

Nov. 14–17
American Petroleum Institute, 35th annual meeting, Mark Hopkins, Fairmont, St. Francis, Palace Hotels and Curran Theatre, San Francisco, Calif.

Nov. 14–17
Second International Automation Exposition, Navy Pier, Chicago, Ill.

Nov. 16–18
Society for Experimental Stress Analysis, annual meeting, Hotel Sheraton, Chicago, Ill.

(ASME Calendar of Coming Events, see page 937)

Proceedings of Peaceful Uses of Atomic Energy Congress

United Nations Will Publish Proceedings of the International Conference

Dag Hammarskjold, Secretary-General, announced the forthcoming publication by the United Nations of the Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, held in Geneva in August, 1955.

The Proceedings, which will be published in 16 volumes of approximately 500 pages each, will constitute the complete, unabridged record of the Conference, and comprise all papers, whether presented orally or in written form at the Conference, together with a record of the discussions concerning each paper.

These Geneva papers will be published by the United Nations in several languages; the English edition will be available in the beginning of 1956, the other at a later date still to be determined.

The publication, in full, of the Geneva papers is considered unique in that it will be the only publication which will make available, in their entirety, the more than 1000 scientific papers submitted at the Conference by over 30 countries and international agencies, and will constitute the only complete record of the Conference, at which approximately 1200 scientists from 72 countries participated.

Any of the individual scientific papers, in mimeographed form, may be purchased at 25 cents each by designating the author and title from the United Nations Bookshop.

The following are the tentative titles of the 16 volumes:

1 "The World's Requirements for Energy; The Role of Nuclear Power"
2 "Physics; Research Reactors"
3 "Power Reactors"
4 "Cross Sections Important to Reactor Design"
5 "Physics of Reactor Design"
6 "Geology of Uranium and Thorium"
7 "Nuclear Chemistry and the Effects of Irradiation"
8 "Production Technology of the Materials Used for Nuclear Energy"
9 "Reactor Technology and Chemical Processing"
10 "Radioactive Isotopes and Nuclear Radiations in Medicine"
11 "Biological Effects of Radiation"
12 "Radioactive Isotopes and Ionizing Radiations in Agriculture, Physiology, and Biochemistry"
13 "Legal, Administrative, Health and Safety Aspects of Large-Scale Use of Nuclear Energy"
14 "General Aspects of the Use of Radioactive Isotopes; Dosimetry"
15 "Applications of Radioactive Isotopes and Fission Products in Research and Industry," and
16 Record of the Conference.

A special prepublication price of $110 (USA), £39, 450.00 Sw. fr. for the full series of 16 volumes has been established. This will be protected for all advance orders received up to December 31, 1955. Orders for the full series, or for individual volumes (final prices to be announced) may be placed with the United Nations sales agents or the United Nations Headquarters Bookshop.

AMA Reports Engineers' Earnings Increasing

Engineers and other professional employees in American industry now are earning about 4.5 per cent more than they earned last year according to a survey of compensation paid to administrative and technical personnel just completed by the Executive Compensation Service of the American Management Association. The majority of the companies surveyed reported granting salary increases to individuals in this group during the past year.

The study, the second on this subject the association has conducted, covered 20 engineering and professional job categories in 19 industries. It is part of a continuing series designed to report salary ranges for specific "exempt" (from compulsory overtime penalty pay provisions of the Fair Labor Standards Act) jobs in business and industry. Most of the positions studied are technical or highly specialized in nature; typical are those of development chemist, project engineer (electrical or mechanical), industrial engineer, and sales engineer.

Considering the great demand for, and short supply of, professional personnel, the range of salaries reported in the survey is surprisingly narrow, the AMA report says. The average beginning engineer receives about $4500 a year. Median pay for industrial-engineering positions is approximately $6000 annually; for chemical positions, $6500; for electrical and mechanical engineering, $7000.

The pay level for these 20 administrative and technical positions is just about the same as that of production foremen, as indicated by a recent AMA survey of foreman compensation. Like foremen and like "middle-management" personnel (those between first-line supervision and the policy-making level), individuals in similar professional and administrative positions tend to receive similar salaries regardless of geographic location. In contrast to management compensation, which usually is higher in larger companies, their salaries do not vary significantly among industries or with company size, the study indicates.

Technical and professional employees are less likely to receive bonuses in addition to their salaries than are foremen and middle-management personnel. Only a fifth of the individuals included in the new survey received bonuses this year, as compared to a fourth of the foremen and two-fifths of the middle-management executives.

Like the other reports of the AMA's Executive Compensation Service, the administrative and technical-position surveys are designed to help companies evaluate their compensation policies in the light of current practice in other firms. These confidential studies are available on a subscription basis to business and industrial executives who have responsibility for administration of the compensation involved.

1956 Power Conference to Stress Nuclear Power

Nuclear-power production and the construction of high-temperature high-pressure power plants will highlight the 18th annual American Power Conference at the Hotel Sherman, Chicago, March 21–23, 1956.

The conference is sponsored by Illinois Institute of Technology in co-operation with 13 universities and nine national and regional technical societies.

More than 3000 executives, engineers, educators, and government officials will attend the three-day conference, which also will have technical sessions on central-station power plants and equipment, hydroelectric power, water resources, air pollution, and electrical transmission and distribution.

Conference director Roland A. Budenholzer, Mem. ASME, professor of mechanical engineering at Illinois Tech, expects approximately 1000 persons to attend the All Engineers' dinner and sessions on nuclear power. Companies planning construction of nuclear-power plants will report on their progress.

Much interest will be centered on technological and economic problems of building supercritical (high-temperature high-pressure) power plants, which are expected materially to reduce power costs in the future.

Universities co-operating with Illinois Tech in sponsoring the conference are: Michigan State, Northwestern, Purdue, Iowa, Iowa State, Illinois, Michigan, Minnesota, Wisconsin, Texas A&M, California Tech, Georgia Tech, and M. I. T.

Co-operating technical societies are: American Institute of Chemical Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers, American Society of Heating and Air Conditioning Engineers, The American Society of Mechanical Engineers, National Association of Power Engineers, Western Society of Engineers, and Engineers' Society of Milwaukee.

AIEE Announces Meetings Six Years in Advance

Setting of meeting dates through the next six years by the American Institute of Electrical Engineers was announced by Nelson S. Hibshman, secretary of the Institute.

Mr. Hibshman states that the setting of dates far in advance is in accordance with a recently adopted policy of the Board to fix meeting dates so that conflict with the dates of meetings of other engineering organizations can be avoided. The dates for the General and District meetings of the Institute have been recommended by the Committee on Planning and Co-Ordination and approved by the Board of Directors.

Future meeting dates which have been approved are as follows:

1955	Oct. 3–7	Fall General	Chicago, Ill.
1956	Jan. 3–Feb. 3	Winter General	New York, N. Y.
	April 2–4	South West District	Dallas, Texas
	April 16–18	Great Lakes District	Fort Wayne, Ind.
	May 2–4	North Eastern District	Rochester, N. Y.
	June 25–29	Summer & Pacific General	San Francisco, Calif.
	Oct. 1–5	Fall General	Chicago, Ill.
1957	Jan. 21–25	Winter General	New York, N. Y.
	April 3–5	Southern District	Jackson, Mich.
	May 1–3	North Eastern District	Pittsfield, Mass.
	May 7–9	Middle Eastern	Dayton, Ohio
	June 24–28	Summer General	Montreal, Que.
	Aug. 26–30	Pacific General	Yakima, Wash.
	Oct. 7–11	Fall General	Chicago, Ill.
1958	Jan. 20–24	Winter General	New York, N. Y.
	June 23–27	Summer General	Buffalo, N. Y.
	Aug. 19–22	Pacific General	Sacramento, Calif.
	Oct. 27–31	Fall General	Pittsburgh, Pa.
1959	Jan. 19–24	Winter General	New York, N. Y.
	June 22–26	Summer General	Seattle, Wash.
	Oct. 12–16	Fall General	Chicago, Ill.
1960	Feb. 1–5	Winter General	New York, N. Y.
	June 19–24	Summer General	Atlantic City, N. J.
	Oct. 10–14	Fall General	Chicago, Ill.
1961	June 19–23	Summer General	Ithaca, N. Y.

ASME Boston Section to Hold Nuclear-Power-Plant Symposium

The Boston Section of ASME, through its Professional Activities Committee, will sponsor a symposium Saturday, October 29, on "Nuclear-Power Plants." Four speakers closely associated with various phases of this type of work will cover the fundamentals of nuclear power, heat-transfer problems, and features of the equipment in reactor-power plants. The symposium will be held at either the Massachusetts Institute of Technology or Harvard University and will start at 9:30 a.m., continuing to 5:00 p.m., with luncheon at 12:30. The lectures will not exceed an hour each which will allow time for discussion periods. Attendance at the symposium is not restricted to members of the Boston Section, ASME, nor is it limited to ASME affiliates. Reservations are requested and may be obtained upon application to Engineering Societies of New England, 715 Tremont Temple, Boston 8, Mass.

SAE Golden Anniversary Meeting on Aeronautics, Los Angeles, October 11–15

An invitation has been graciously extended by C. G. A. Rosen, Fellow ASME, and SAE president, to the members of The American Society of Mechanical Engineers to attend the Society of Automotive Engineers Golden Anniversary Aeronautic Meeting at the Hotel Statler in Los Angeles, Calif., October 11–15.

Since first held in 1936, the Aeronautic Meeting has grown to an attendance of over 2500, indicative of how effectively the programs have been designed to serve the aviation industry. In this Fiftieth Year of SAE history, an even greater effort has been made to schedule discussions and papers which will give practical technical information to assist aeronautical engineers in the better performance of their jobs. The meeting will open with a two-day Aircraft Production Forum. The Aeronautic Meeting is one of the major events marking SAE's fiftieth year.

Literature . . .

Electric-Utility Engineering

A new book "Principles of Electric Utility Engineering" by Charles A. Powel, has been published jointly by the Technology Press of the Massachusetts Institute of Technology and John Wiley & Sons, Inc. Price of the book is $6.

The 251-page book reviews the everyday problems facing the electric-utility engineer in all branches of the industry. Typical chapters discuss: Corporate organization, objectives, and finance; sources of energy; steam-generating stations and their auxiliaries; transmission systems and equipment; power distribution; power-system fault control, lighting phenomena, and insulation co-ordination.

Mr. Powel, the author, has had 43 years' experience in power engineering. After graduating from the Institute of Technology, Bern, Switzerland, in 1905, he served 10 years with Brown Boveri and Company, including four years as resident engineer in Japan. In 1919 he joined Westinghouse Electric Corporation, where he remained until his retirement in 1949 as assistant to the vice-president of engineering. He then joined the staff of M.I.T., where he lectured on everyday problems of the utility industry until 1954. He is a past-president of the American Institute of Electrical Engineers.

Hundreds of Engineering Students Attended 12 ASME Regional Student-Branch Conferences

Worth-while papers, interesting trips, and excellently planned meetings brought out the crowd

This year, during the months of April and May, 1488 students from 128 engineering schools in the United States and Canada journeyed, some from considerable distances, to attend 12 Regional Conferences held by the Student Branches of The American Society of Mechanical Engineers.

The "little" annual meetings are designed to give the students some conception of the benefits to be derived from taking an active part in a professional meeting—a step toward participation in Society affairs on a national plane; the opportunity to compare and discuss Student-Branch accomplishments and in forum to find solutions to problems hindering greater achievement; and to become acquainted with one another. But the most significant thing about these meetings is the eminently worth-while papers which the students present.

A Pattern Develops

A survey of opinions expressed on the perennial question of attendance revealed that neither afternoon meetings versus evening meetings, the added attraction of sports or professional films, nor social functions actually stir up large attendances. The consensus indicated that improvement could be expected if the student chairmen were chosen with more care and the interest of the faculty adviser sparked an inspiring, strong student-counselor program. It was suggested that students be encouraged to seek out projects by which a contribution could be made to the

mechanical-engineering department and the school. It is loyalty to one's basic profession, a speaker pointed out, that should be a motivating factor in influencing postgraduate professional activity. Several engineering schools reported 100 per cent potential membership.

A four-point suggestion whereby students could derive more benefit from their membership in ASME gave wider latitude for student initiative as follows: (1) Instead of professors or guests as speakers at meetings, have students do the speaking at most of the gatherings as a means of developing the skill of oral expression. (2) If plant trips are desired, have students make all the arrangements through interviews with plant officials and develop a feeling of confidence in personal contacts with other engineers. (3) Assign different groups of students to the job of planning meetings so that all have the opportunity to participate. (4) In addition to talks on purely technical subjects arrange for speakers such as patent lawyers, investment brokers, or industrialists to give an insight into some other phases of postgraduate living.

According to reports, transfer from Student Member to Associate Member is progressing fairly successfully percentagewise. It seems that the lapse during the first five years as Associate is the result of too much emphasis on "What can I get?" and not enough on "What can I contribute?"

High Lights of the Meetings

Inspection trips were arranged to the scientific and technical laboratories at all the host schools; local industry welcomed the visitors to research and development laboratories and operational plants. In some instances the emphasis was placed on tours of the large cities rather than any particular institution or plant.

All the conferences were climaxed by award luncheons or banquets with leading local engineers and officers of the Society as speakers. U. S. Senator Ralph E. Flanders of Vermont, past-president and Hon. Mem. ASME, addressed the Region IV banquet held in Charlottesville, Va.

The four student-paper prizes and the Old Guard prize—difficult as it was to make the choice according to all reports—were presented at all the 12 conferences. In addition prizes were given for the largest and second-largest percentage of members attending, the Man-Mile Trophy, and Potential Membership Certificate.

At the banquet held in Toronto, Ont., Can., Thompson Chandler, Vice-President, ASME Region V, presented the 75th Anniversary Certificate and Medal to J. N. Rossall, who was selected as the outstanding student at the University of Toronto.

David W. R. Morgan, President of ASME, on his tour of the Sections throughout the United States, made it a point wherever possible to attend the Student Conferences. He gave inspiration to the conferees in his talks on the student engineer in our world. On his visit to the Pacific Southwest Conference in Region VII, at the University of California, at Berkeley, Dr. Morgan addressed the assembled group of students who joined with the members of the ASME San Francisco Section on the occasion of the presentation of Honorary Membership in the Society to Dean George L. Sullivan of the University of Santa Clara.

Faculty Advisers Meetings

At the meetings of the Faculty Advisers, formerly known as Honorary Chairmen, the following questions were discussed: The duties of the faculty advisers, eligibility of the host colleges to participate in the papers contest, the responsibility of the faculty adviser as regards the transfer of a student to associate membership, and encouragement of wider participation in the competition for the Charles T. Main Award.

In discussing the scoring, the faculty advisers recommended that consideration be given to bringing the regional student winners together for competition at the national level, either at the Semi-Annual or Annual Meeting of the Society, thereby giving an incentive to potential "authors." It was further recommended that all who participated in the papers contest should receive a certificate, thus giving recognition to participants who do not win the cash awards.

All the student meetings were concluded with gracious tributes to the host school and all who made possible an excellent technical meeting for the warm hospitality while on the campus and at various tours of inspection to industrial plants or civic points of interest. All meetings, as nearly as possible, arranged dates for 1956 Conferences.

The following tables list the recipients of awards for papers and Student Branches for attendance.

1955 ASME Regional Student Conference Winners

REGION I, NEW ENGLAND, NORTHEASTERN UNIVERSITY, BOSTON, MASS., APRIL 22–23, 1955

Attendance: 247 — Papers Presented: 12

Prize	*Recipient*	*Title of Paper*	*College*
First	Douglas A. East	Investigation of Particle-Size Measurement in a High-Speed Aerosol	Massachusetts Institute of Technology
Second	John Buffington	Rockets for Metal Spraying	Dartmouth College
Third	Robert S. Stemple	Practical Fuel Injections for Automobiles	Worcester Polytechnic Institute
Fourth	Fred A. Joest	Nonreciprocating Piston Engine	Brown University
Old Guard	Harley Lane	A Dynamometer for Small Combustion Engines	Clarkson College of Technology

REGION II, EASTERN, NEWARK COLLEGE OF ENGINEERING, NEWARK, N. J., APRIL 21, 1955

Attendance: 160 — Papers Presented: 5

Prize	*Recipient*	*Title of Paper*	*College*
First	John Kennedy	Designing a Homemade Aqua Lung	Newark College of Engineering
Second	Edward I. Riegelhaupt	The Critical Properties of Steam	Brooklyn Polytechnic Institute
Third	Myron Katz	The Preliminary Design of Automotive Engines	Cooper Union School of Engineering
Fourth	Herbert Geissler	Automotive Power Plants	City College of New York
Old Guard	Rodney Thurston	The Accuracy of Small Coal Samples	Columbia University

REGION III, ALLEGHENIES, THE JOHNS HOPKINS UNIVERSITY, BALTIMORE, MD., APRIL 29–30, 1955

Attendance: 102 — Papers Presented: 12

Prize	*Recipient*	*Title of Paper*	*College*
First	William R. James	A Portable Swimming-Pool Filter	Princeton University
Second	Thomas H. Arnott	Automobile Air-Conditioning Control Systems	Cornell University
Third	Hank Bode	A Practical Measurement of Aerodynamic Forces	Swarthmore College
Fourth	Jerome E. Ruzicka	A Method of Determining Damping Characteristics of a Vibrating Beam	The Johns Hopkins University

Prize	Recipient	Title of Paper	College
Old Guard	John W. Kelly	Engineers in Management	University of Delaware

REGION IV, SOUTHERN, UNIVERSITY OF VIRGINIA, CHARLOTTESVILLE, VA., APRIL 1–2, 1955

Attendance: 109 Papers Presented: 13

Prize	Recipient	Title of Paper	College
First	Colin A. Harrison	Application of the Electric-Discharge Machine Tool for Machining Forge-Shop Dies	University of Virginia
Second	Kendrick C. Hardcastle, 3rd	Instrumentation for the Study of the Relationship of Dynamic-Static Coefficient of Friction	Vanderbilt University
Third	Wade M. McGee	Design of a Torquemeter for Measuring Small Torques	North Carolina State College
Fourth	Robert H. Davis	The Engineer in the Plumbing Industry	Georgia Institute of Technology
Old Guard	James F. Schaeffner	Pulpwood Harvesting—Some Consideration for Increasing the Efficiency of the Operation Through Planned Mechanization	University of Florida

REGION V, MIDWEST, UNIVERSITY OF TORONTO, TORONTO, ONT., CAN., APRIL 28–29, 1955

Attendance: 150 Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	Joseph F. Onofrey	New Life for Dies With Carbides	University of Pittsburgh
Second	Paul Vergamini	The Aircraft Gas-Turbine Compressor	University of Dayton
Third	Reid Agnew	Experimental Stress Analysis	Carnegie Institute of Technology
Fourth	C. Boyd Murdock	A New Procedure for Hardening Metals	University of Toledo
Old Guard	William Flumerfelt	The Hilsch Tube	Ohio State University

REGION VI, NORTHERN TIER, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN., APRIL 22–23, 1955

Attendance: 85 Papers Presented: 9

Prize	Recipient	Title of Paper	College
First	James L. Haugen	Human Engineering of Airplane Cockpits	University of North Dakota
Second	Harry A. Nelson	Heavy Fuel Oils for Diesel-Power Generation	North Dakota Agricultural College
Third	Louis A. Fazzari	Motion Pictures—A Key to Motion Analysis	Marquette University
Fourth	Earl W. Hagen	The Binary-Number System and Its Application to High-Speed Computing Machines	South Dakota School of Mines and Technology
Old Guard	Lawrence E. Efferding	Magnetostriction	Iowa State College

REGION VI, SOUTHERN TIER, BRADLEY UNIVERSITY, PEORIA, ILL., APRIL 28–29, 1955

Attendance: 154 Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	Robert E. Mott-Smith	Sand Fracing	Purdue University
Second	John M. Scriba, Jr.	Sales Engineering	University of Notre Dame
Third	Robert A. Miller	Simulated Flow-Pattern Comparison	Missouri School of Mines
Fourth	Charles H. Garrigues	Magnetic-Particle Clutches	Northwestern University
Old Guard	Donald H. Wykes	Why Air Suspension?	Bradley University

REGION VII, PACIFIC NORTHWEST, OREGON STATE COLLEGE, CORVALLIS, ORE., MAY 4–6, 1955

Attendance: 92 Papers Presented: 11

Prize	Recipient	Title of Paper	College
First	John J. Greytak, Jr.	Use of Brush and Commutator for Primary Current Distribution in Automotive Ignitions	Montana State College
Second	Leroy L. Presley	Automatic-Control System for Vertical Take-off Model Aircraft	Oregon State College
Third	Carl R. Johnson	Gilsulate Insulation Test	University of British Columbia
Fourth	Glen W. Hostetler	Absorption Refrigeration for Automobile Air Conditioning	University of Idaho
Old Guard	Vernon W. Kautz	Development of a New Type of Steam Engine	University of Washington

REGION VII, PACIFIC SOUTHWEST, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIF., MAY 5–7, 1955

Attendance: 121 Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	Henry A. McKenna	Characteristics of the Back-Pressure-Type Pneumatic Gage	University of Santa Clara
Second	William A. Boyd	Flexure Tests on Lightweight Concrete Roof Decks	University of Utah
Third	Frederick F. Fletcher, Jr.	Variable-Velocity Journal-Bearing Friction	University of California
Fourth	William F. Lapson	Our Guided Missiles	California Institute of Technology
Old Guard	Donald H. Johnson	A Discrepancy in the Use of Heating Values of Fuels	University of Santa Clara

REGION VIII, NORTHERN TIER, UNIVERSITY OF OKLAHOMA, NORMAN, OKLA., APRIL 18–19, 1955

Attendance: 105 Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	Virgil E. Carrier	Thermoelectric Power	Kansas State College
Second	Kenneth L. Smith	The Barker's Bite	University of Arkansas
Third	Charles E. Nelson	Mechanical Problems Associated With High-Speed Track Testing	Oklahoma A&M College
Fourth	James C. Rogers	Inlet Diffusers for Jet Engines	Kansas State College
Old Guard	Billy E. Ferrell	Trends in Jet-Engine Fuels	University of Oklahoma

REGION VIII, ROCKY MOUNTAIN TIER, UNIVERSITY OF NEW MEXICO, ALBUQUERQUE, N. MEX., APRIL 29–30, 1955

Attendance: 53 Papers Presented: 15

Prize	Recipient	Title of Paper	College
First	Marvin D. Tevebaugh	An Economical Fork-Lift Truck	University of Denver
Second	James E. Medford	Dynamic Similarity Applied to Pressure Vessels	Texas Technological College
Third	A. M. Abo Naba'a	Engineering Education in the Near East	New Mexico College of Agricultural and Mechanic Arts
Fourth	Henry M. Davidson	Modern Methods in the Creosote Treatment of Wood	University of New Mexico
Old Guard	Robert Christopher	Influencing Factors in the Development of Naval Marine Boilers	University of Colorado

REGION VIII, SOUTHERN TIER, RICE INSTITUTE, HOUSTON, TEXAS, APRIL 25–26, 1955

Attendance: 110 Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	Robert F. Fletcher	Ljunstrom-Type Evaporative Cooling System	University of Texas
Second	Bernard J. Walker	The Effects of Aircraft Gas Turbines on Aircraft Maintenance	Louisiana State University
Third	Ray J. Flaskamper	Butane and Propane as Internal-Combustion Fuels	University of Texas
Fourth	Charles T. Essmeir	Off-Shore Drilling Platforms	Louisiana Polytechnic Institute
Old Guard	Robert L. Cloud	Nuclear Reactors and Power Plants	Agricultural and Mechanical College of Texas

Prizes Other Than Papers Presented at the Regional Student Conferences—1955

1 Two prizes of $25 and $15 were awarded at each Conference to the Student Branches, other than the host college, having the largest and next largest percentage of Student Members attending.

2 A certificate was presented at each conference to the Student Branch having the largest percentage of potential Student Membership in the third through sixth years among Student Branches participating.

3 Each Conference presented a Man-Mile trophy for the Student Branch that traveled the greatest number of man-miles to the Conference. The winners are listed in the following table:

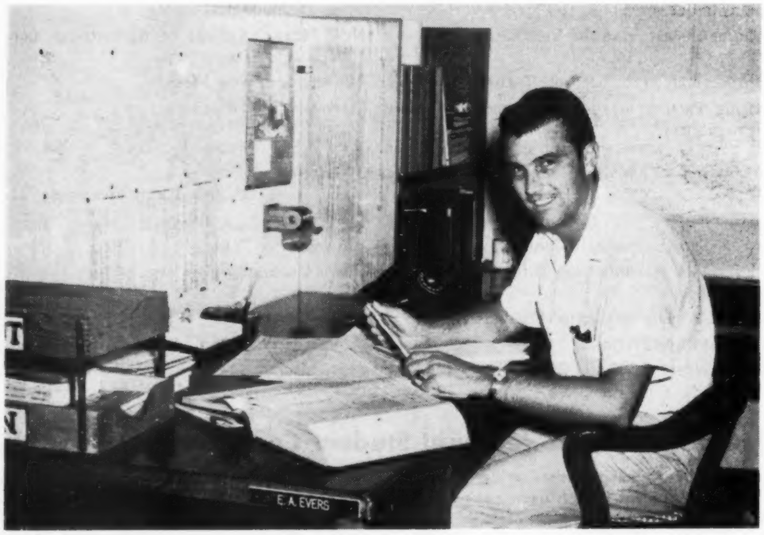
Region	$25	$15	Potential Student-Membership Certificate	Man-Mile Trophy
I	Norwich University	Tufts College	University of New Hampshire and Thayer School	Norwich University—Region I Trophy University of Maine—ASME Plaque
II	Pratt Institute	College of the City of New York	Pratt Institute	Pratt Institute
III	Catholic University of America University of Delaware		Catholic University of America, University of Delaware, and Swarthmore College	University of Rochester
IV	Virginia Polytechnic Institute	University of South Carolina and Clemson Agricultural College	University of South Carolina	Mississippi State College
V	University of Dayton	Wayne University	University of Dayton	University of Dayton
VI—Northern Tier	South Dakota State College	North Dakota Agricultural College	University of North Dakota	South Dakota State College
VI—Southern Tier	Rose Polytechnic Institute	University of Louisville	Rose Polytechnic Institute	Rose Polytechnic Institute
VII—Pacific Northwest	Washington State College	University of Idaho	Washington State College	University of British Columbia
VII—Pacific Southwest	University of Santa Clara	University of Utah	United States Naval Postgraduate School	University of Utah
VIII—Northern Tier	Kansas State College	University of Arkansas	University of Arkansas	Kansas State College
VIII—Rocky Mountain Tier	Texas Technological College	University of Colorado	University of New Mexico	University of Wyoming
VIII—Southern Tier	Louisiana State University	Louisiana Polytechnic Institute	Rice Institute	Louisiana State University

Junior Forum . . .

Conducted by R. A. Cederberg,[1] Assoc. Mem. ASME

The Young Mechanical Engineer Working Overseas

By Eugene A. Evers[2]



The author is shown at work in his office at the Lago Oil & Transport Co., Ltd., in Aruba, Netherlands W. I.

If a young engineer accepts a position overseas, what can he expect? Is the work different? Are living conditions desirable? How will the position affect his future? Possibly I can answer these questions for some of you by briefly describing what I have experienced in my position as a mechanical engineer in an overseas industry.

For the past few years I have been employed by the Lago Oil & Transport Co., Ltd., a subsidiary of the Standard Oil Co. (N. J.) at their refinery in Aruba, Netherlands W. I. Aruba is a small island located just north of the coast of Venezuela. Based on crude throughput, the Lago Refinery is the largest operating in the world, with a capacity of 440,000 barrels per day. All of the oil refined comes from Venezuela. This vast operation necessitates transportation of the crude oil by ship to Aruba, refining of this crude oil in Aruba, and shipment of the products, primarily fuel oil, to markets anywhere from 150 to 12,000 miles distant.

[1] Westinghouse Electric Corp., Radio-Television Division, Metuchen, N. J.

[2] Lago Oil & Transport Co., Ltd., Aruba, Netherlands W. I. Assoc. Mem. ASME.

As one of the young mechanical engineers at the Lago Refinery, my work is concerned with the supply of utilities to the refinery. These utilities include power, process steam, cooling water for the refinery heat exchangers, compressed air, drinking water, and an adequate emergency supply of water for fire-fighting purposes. Previous to entering foreign service, I had several years' experience with a power utility in the United States.

How Overseas Service Differs

Basically, the work of a mechanical engineer overseas does not differ greatly from that in the United States in that it is a matter of the practical application of engineering principles. However, there are certain differences. Possibly the prime difference concerns the fact that the majority of the employees in an overseas industry are local people, who for the most part are unaccustomed to highly specialized industrial methods and practices. The engineer working in an overseas industry must constantly keep this fact in mind, particularly in design work. Process designs must be made as simple and foolproof as possible. Construction and maintenance forces also require constant and close supervision to insure proper installation. Of course this situation improves the longer the industry remains in the area.

Another difference is the fact that the industry overseas is a long distance from the manufacturers of equipment and materials. The engineer overseas therefore must frequently specify equipment and materials without the recommendations of the manufacturer. When equipment does not operate properly, he must solve the problem himself, usually without help from the manufacturers.

Still another difference is the fact that engineers in overseas positions are rarely specialists. Rather, the engineer working overseas is called upon to do jobs that carry him into many fields of engineering. Because of the high cost to send and maintain an engineer abroad, these companies prefer engineers with varied experience. As a result the engineer may expect to be rotated frequently in his assignments.

What Advantages?

Considering the foregoing differences, what are the advantages and disadvantages to the young mechanical engineer working overseas? The first, and probably the most important, advantage is the opportunity to obtain diversified experience. This is the direct result of the policy of rotating engineers in their job assignments to give them experience in various fields of engineering. To the young engineer out of college, who very likely does not know definitely the type of work he wishes to follow, such diversified experience is invaluable. It not only gives him a broad background of engineering experience for later life, but also permits him to more intelligently select a field in which to specialize as he gets older.

Secondly, circumstances in an overseas position present the young engineer with unusual opportunities to do his own thinking and make his own decisions. Distance from manufacturers, and inaccessibility of information and recommendations from them, practically force the engineer to do his own thinking. I am convinced, therefore, that an overseas position offers better opportunity for a young engineer to learn to depend on himself.

A third advantage to a young engineer working overseas concerns the fact that his chances for a position of responsibility generally come much sooner than could be anticipated under similar domestic conditions. This of course is the result of a higher turnover rate in an overseas industry. For the young engineer desiring to make a career of foreign service, the opportunities for promotions to positions of responsibility are excellent.

Finally, and certainly not the least important, the engineer working overseas receives a salary considerably in excess of that which could be expected under similar conditions in the United States. Depending upon the company and the industry, this may be as much as 25 per cent or more. Generally, too, the cost of living in a foreign country is less than in the States. Furthermore, to encourage technical people to work abroad, the U. S. Government has provided tax exemption for

those remaining outside the United States for longer than 18 months. With such advantages, it is not difficult to save a relatively high percentage of your salary.

Although these advantages are very important to the young engineer, it must be realized that there are certain disadvantages in working overseas, which may tend to hinder his future career.

What Disadvantages?

Among these disadvantages is the fact that there is no opportunity to continue his engineering education. Because of the present-day complexity of engineering and its applications, it becomes increasingly important for a young engineer to continue his education after graduation. Unfortunately, the young engineer must forego such opportunity when he accepts a foreign assignment.

Too, there is little or no opportunity to attend the lectures and discussions sponsored by the engineering societies such as ASME. Undoubtedly this is an excellent means of keeping up with recent engineering developments. Since opportunities to attend these meetings and enter into these discussions are not available to the engineer overseas, he must keep abreast by other means such as by more thorough reviews of technical papers, journals, and publications, when available.

Another disadvantage in working overseas is the fact that your contacts with other engineers are limited to those of one industry. Contacts with engineers in other industries, naturally, serve to broaden an engineer's viewpoint and make him more aware of the engineering problems arising outside his own field. As a rule, foreign assignments do not offer such opportunities.

I consider these to be the primary advantages and disadvantages to the career of a young engineer in an overseas industry. But what about the life and living conditions to be expected when working abroad?

Living Conditions

Admittedly, the life and living conditions outside the U. S. will vary widely depending upon the location and the individual company concerned. Most companies realize, however, that living conditions greatly affect the turnover rate of the people they send abroad, and consequently the best possible living conditions are generally provided for their overseas personnel.

An example of living conditions overseas is the arrangement here at the Lago Refinery. This community of 600 foreign staff employees has an elementary school with teachers employed from the United States, a hospital with adequate medical facilities, a church, and a commissary for food purchases. The bungalows are quite adequate, and are completely maintained by the company. Entertainment includes movies, amateur-theatrical productions, sport activities, and occasionally professional entertainment. Most of the time, however, instead of being entertained, we provide our own entertainment. As a rule, no great hardship in living conditions must be endured by the individual working overseas.

Furthermore, all companies provide liberal vacations which permit you to return to the United States for prolonged periods. Usually a two-week local vacation is given during the first year and a furlough vacation of two months or more the second year. These vacations also permit extensive travel in foreign countries which is one of the attractions of foreign service to those interested in travel.

I have covered briefly the most important aspects of the work and the life to be expected in an overseas position. Naturally, my views are based upon the experiences I have had in foreign service, but in general these experiences should be comparable to most other foreign positions. Each individual must of course weigh the advantages and disadvantages to himself before embarking on an engineering career overseas. However, should a career overseas appear attractive to a young engineer, there is no question but that the engineering experience to be gained is of the best and the opportunities open to him are unlimited.

Education . . .

Fellowship

Establishment of The International Nickel Company, Inc., Fellowship at Harvard University for research in metallurgy was recently announced.

The grant by the company is to continue for five years. Of the approximately $8000 to be provided each year, half will be used for one or more fellowships and the other half may be used by the University's Division of Engineering and Applied Physics at its discretion.

The initial fellowship, for the year 1955–1956, has been awarded to Ulrich F. H. Kocks of Göttingen, Germany.

The University and International Nickel have agreed that the results of any research undertaken under this fellowship be made available to the public.

Evening Graduate Program

A new booklet describing the evening graduate program of Stevens Institute of Technology has just been issued by the Hoboken, N. J., engineering college.

The booklet entitled "Graduate Study at Stevens," outlines the scope of the graduate work in eight departments, each of which offers the MS degree. Three of the departments, chemistry and chemical engineering, mathematics, and physics, also grant a PhD degree. The department of mechanical engineering confers the DS degree in applied mechanics.

The Stevens graduate program, the publication states, recognizes the "close alliance between the engineering college and industry as a force for progress." By offering graduate work in the evening only, it notes, the Institute enables engineers and scientists working in industry in the metropolitan New York-New Jersey area to continue to be productive employees while preparing for greater contributions to their companies.

The booklet lists 188 courses at the graduate level and notes that many may also be taken without reference to a degree, provided the student meets the usual entrance requirements.

Engineers and Managers

To contribute to the development of engineers and managers and to prepare them for higher management responsibilities, University of California Extension and the College of Engineering and School of Business Administration on the Los Angeles campus of the University will offer an Engineering and Management course from January 23 to February 2, 1956.

Inaugurated at UCLA last January, the program, first of its kind to offer instruction in both the traditional and the new areas of industrial engineering and management theory and practice, brought executives, managers, and supervisors from firms throughout the United States, Canada, and the Hawaiian Islands to the Los Angeles campus.

The ten-day, 8 a.m. to 5 p.m., course will include 20 offerings covering general-management subjects, traditional industrial engineering, and new principles and new techniques such as automation and electronic-data processing for business and industry. Early applications for admission this year indicate that the number of applicants will exceed 125, the total number which will be admitted.

Each participant may choose a program tailored to his own needs to improve his current job performance, prepare him for a new assignment, or supplement his company's training program.

Information folders and application blanks are available on request to Mr. Edward P. Coleman at the College of Engineering, University of California, Los Angeles 24, Calif.

Conveyer Automation

Armand T. Gaudreau, Mem. ASME, management consultant, Westport, Conn., will direct the Conveyer Automation Clinic Sessions at the Second International Automation Exposition, Chicago, Ill., Navy Pier, Nov. 14–17, 1955.

Each lecture of the Clinic will be focused on a different, functional phase of the application of conveyers in supplying the prime mechanism to automation: Work positioning at the machines, intermachine transfers of materials, interflow handling of materials, interbuilding transportation of materials, automatic handling from assembly to storage, and integrating material flows through production.

Mr. Gaudreau has conducted courses for engineering executives and management personnel, including the Conveyer Institute arranged by the University of Illinois in cooperation with The Conveyer Equipment Manufacturers Association in 1953.

The Electronic Computer Clinic will be repeated this year but will be twice as large. The Clinic will again be under the direction of Milton Aronson, editor of *Instruments and Automation.*

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

Men Available[1]

Industrial Engineer, ME, 31, married, candidate MS(IE), Columbia, 7 years' industrial experience. Desires position with administrative opportunities in control functions: Production, inventory, quality, or budgetary; or economic engineering. Commuting distance New York City. Me-252.

Executive, graduate, 64; many years' experience all phases of industry; foreman, superintendent, works manager, general manager, professional consultant. Just returned from France after four years' service with Marshal Plan agencies as chief of industry division. Thoroughly acquainted with French industry in general and many concerns in particular. Qualified to act as consultant or adviser in matters pertaining to industry, domestic or foreign. Me-257.

Mechanical Engineer, 37, married, BS(ME), PE, 16 years' diversified experience in general maintenance, construction-design and supervision; familiar with tool design, special equipment, and heat transfer. Fluent French and German. Desires responsible position. Me-258.

Quality-Control Manager, BSME, 45, 14 years' experience in test, inspection, quality-control methods; ten years planning engineer in metal-working shop. Location, immaterial. Me-259-282-Chicago.

Project Engineer, BS(ME), 30, four years' experience in the development and design of devices relative to the pneumatic temperature-control industry. Chicago, Ill., or suburbs. Me-260-286-Chicago.

Plant Manager, Plant Engineer, or Chief Engineer, BS, 32, ten years supervisory design-metal fabrication and chemical-plant engineering. Me-261-283-Chicago.

Engineer, 31, BS(ME), eight years' experience in research and development, testing, analysis, and product design and development. Desires responsible position. Prefers eastern location. Me-262.

Mechanical Engineer, BSME, 32, married. Nine years' engineering and sales experience. Design and supervision, plant engineering, cost estimating, and proposals in industrial and utility fields. Fluent German and Swedish. Desires position in export sales or allied field, domestic or foreign location. Me-263.

Positions Available

Assistant to Manager, technical services, 32-45, preferably mechanical engineer with textile-machinery experience, to supervise technical service with licensees, design of new machinery, improvements on present equipment, and liaison with manufacturers. New York, N. Y. W-1168.

Assistant Industrial-Advertising Manager, 28-38, engineering training and technical-writing experience covering heating and air conditioning for manufacturing concern. $6000-$7000. N. J. W-1751.

Mechanical Engineer, 25-35, to assist in design and development for mineral dressing, heavy chemical, cement, and rock-products industries. Must have had engineering and field experience and be willing to work on drafting board. $5000-$7500. Pa. W-2027(*b*).

Project Engineer, under 40, mechanical graduate, at least seven years' design and development experience covering small parts and aircraft accessories. To $8500. Northern N. J. W-1991.

Industrial Engineer, graduate industrial or mechanical, young, about five years' experience in methods and packaging; some experience in work performance desirable. Some experience in pharmaceuticals helpful. $6000-$6500. N. J. W-2004.

Equipment Engineer, 35-49, graduate mechanical, ten years' experience in plant engineering, supervision of mechanical and electrical maintenance, drafting and design; plant and equipment layout in heavy industry, steel rolling, and processing preferred. Will plan and estimate plant and equipment expansion, evaluate, specify, and purchase new equipment. To $8400. Pa. W-2007-C-3459.

Plant Engineer, 35-45, mechanical graduate, at least eight years' process and manufacturing equipment maintenance experience covering rubber, plastic, or coated materials. $7000-$8000. Brooklyn, N. Y. W-2011.

Plant Engineers, experienced in printing, paper converting, etc., to supervise all mechanical and building-maintenance requirements in a plant operating high-speed, lightweight, automatic manufacturing equipment, assuming full responsibility for the maintenance department, generation steam, distribution of steam and electricity. About $8400. Midwest. W-2031.

Engineers. (*a*) Plant industrial engineer, 25-35, BS(ME) or IE, with 5 to 10 years' experience in industrial-engineering work with a chemical or process industry. Should have some experience with cost control, standards, time and motion study, man-machine charts, etc., for manufacturer of asphalt tile, vinyl products, etc. $5400-$7200. (*b*) Plant chief industrial engineer, 30-40, BS(ME) or IE, ten to 15 years' experience in IE work, preferably in a chemical or process industry, five years in supervisory work. Will supervise the industrial-engineering activities of the plant. $7200-$9000. East. W-2033.

Design Engineer, mechanical-engineering training, production-machinery experience, to design and lay out machinery, fixtures, tools, and general production equipment. $6000-$7000. Newark, N. J. W-2040.

Administrative Engineer, mechanical or electrical, experienced in the development and design of electric motors and motor-generator equipment ranging in sizes from fractional to 50 hp, for manufacturer of highly specialized equipment of this type. About $10,000. Southern New England. W-2047.

Engineers. (*a*) Senior engineer, 30-44, mechanical or chemical, three years' experience in design, and two years in mechanical or chemical engineering and some experience in general power, steam plant, and rectifier. Experience in thermodynamic calculations, heat-transfer calculations, instrumentation, etc. Will do mechanical engineering involved in plant design. $7260-$9780. (*b*) Design engineer, mechanical, 30-40, BS(ME), with at least five years' experience in machine design, bearings, fittings, and moving-equipment parts. Experience in rolling-mill equipment desired. Will handle machine design, estimating, plant layout, and installation of equipment. $6600. (*c*) Senior engineer, 30-40, mechanical or civil graduate, three years' experience in design, two years in mechanical engineering. Some experience in hydraulic relationships in the design of storm and sanitary-sewerage systems. Familiar with methods of construction codes, hardware, catalogs. Group is engaged in project planning for plant facilities. $7260-$9780. Calif. W-2051.

Production Manager, 35-45, mechanical, industrial, or civil degree, at least ten years' experience in the fabrication of structural steel and metal-building specialties covering production practices, methods and procedures, cost. $10,000-$15,000. Midwest. W-2054.

Designer, under 40, mechanical-engineering training, and at least eight years design, layout, and checking of close-precision cams, gears, etc. $7280. Queens, N. Y. W-2067.

Engineers. (*a*) Experimental engineer, 35-50, mechanical or electrical preferred. Will be resonsible for building, assembling, and altering all test samples or models by means of model makers; conduct all tests performed on the product; supervise quality-control staff, etc. About $10,000. (*b*) Project engineer, 35-50. Responsible for the design of all products under his jurisdiction. Responsible for the establishment of tolerances, limits, settings, timing, and life-expectancy data which characterize the performance limits of the product. About $10,000. Conn. W-2069.

Production Managers, two, for heavy-steel fabrications, to 45, mechanical graduates, experienced with large manufacturing organization, on heavy products such as pressure vessels, tanks, steel structures, directing large and varied labor forces on cutting, welding, riveting, forging, and heavy machining; knowledge of costs and cost-controls, labor relations, etc. $20,000-$25,000. One for middle South and one for eastern seaboard. W-2070.

Engineers. (*b*) Manufacturing executive, engineering and production experience covering general machine shop, plate and welding shop, sheet metal, piping, and assembly of apparatus fabricated of carbon and stainless steels, aluminum, and copper. (*c*) Chief mechanical engineer, mechanical degree, at least eight years' applied development, design, test and manufacturing of turbines, superchargers, compressors, diesel engines, pumps, etc. Salaries open. Pa. W-2074.

Research Engineer, mechanical or applied physicist, advanced degree or equivalent experience permitting him to perform fundamental industrial research in the general fields of fluid dynamics, thermodynamics, and heat transfer. Interest in electronic instrumentation helpful. Should be able to handle various types of problems rather than becoming an expert in one type of problem. Willing to accept project responsibility after job orientation. Salary open. Calif. W-2077.

Design Engineers, either mechanical or chemical graduates, who have had from five to ten years' experience in oil refinery and chemical plants. To $12,000, depending on experience. West Coast. W-2079.

Designer, thoroughly trained and experienced, to design heating, ventilating, and air conditioning, particularly air-conditioning systems for all types of institutional, public, and commercial buildings. Capable of directing work of several junior engineeers. $7800-$9100. Va. W-2082.

Project Engineer, mechanical graduate, for electronic manufacturer, for work on an electronic device employing hydraulic and pneumatic drives. Some experience in air and hydraulic valves desirable. $7000-$10,000. Long Island, N. Y. W-2086.

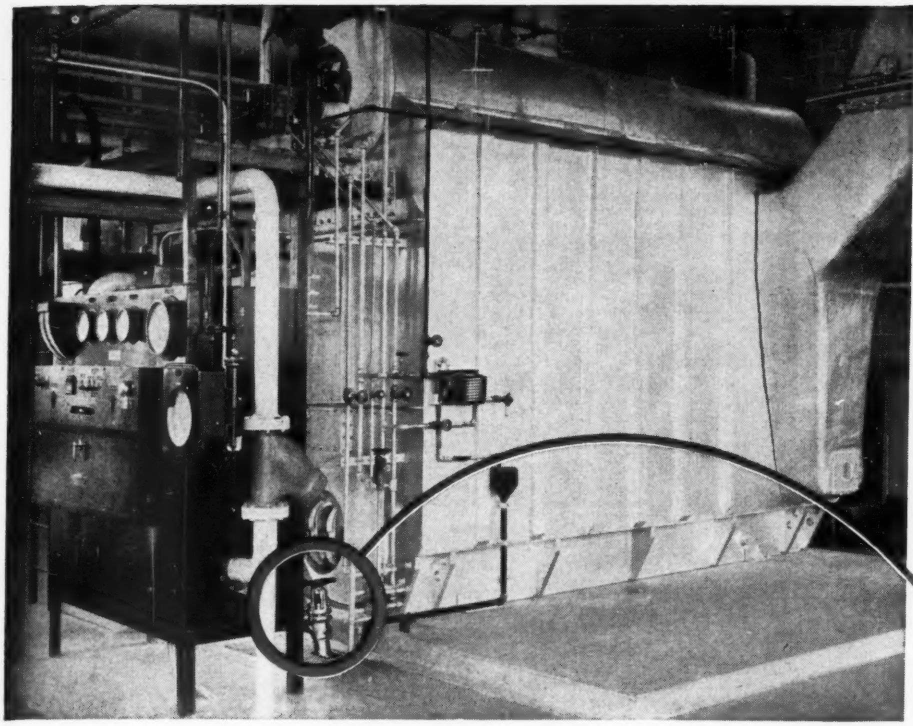
Plant Manager, under 40, mechanical degree, experienced in job-shop and production work, industrial relations, tooling, jigs, fixtures, motion and time study, and methods. Will be responsible for production, purchasing, plant and machine maintenance, and toolmaking. $10,000, with bonus. R. I. W-2090.

Assistant Chief Engineer, mechanical or electrical graduate, design and considerable administrative experience covering contracts and schedules of precision components. $10,000-$12,000. New York, N. Y. W-2100.

Plant Manager, manufacturer of furniture, cabinets, industrial and commercial wood products. Should have broad background in woodworking industries with thorough knowledge of all operations from dry kilns to crate, purchase of lumber and veneers, etc. Knowledge of

(*ASME News continued on page 952*)

[1] All men listed hold some form of ASME membership.



COMBUSTION ENGINEERING ADOPTS YARWAY SEATLESS BLOW-OFF VALVES FOR PACKAGE BOILERS

Combustion Engineering, Inc. on this package boiler installation at the Orangeburg Pipe Plant in California, again includes Yarway Seatless Blow-Off Valves as part of the "package."

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Yarway Type "B" Seatless Tandem Blow-Off Valve. Note balanced sliding plunger design with no seat to score, wear, clog or leak. Pressures to 400 psi.

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industrial engineering as applied to the manufacture of wood products, i.e., standard-cost systems, budgetary-control systems, production and follow-through methods, etc. $8500–$15,000. Pa. W-2104.

Chief Engineer, 35–45, mechanical or chemical graduate, at least ten years' design, plant-engineering, and supervisory process-engineering experience in petrochemical, distilling, or allied industries. $15,000–$18,000. Midwest. W-2133.

Design Engineer, mechanical graduate, design and development experience on compressors and air-conditioning equipment. $6000–$10,000. Midwest. W-2135(*a*).

Research Engineer, carbide-tool and die experience, to take charge of research and development machine shop for powder-metallurgy concern. Salary open. New York metropolitan area. W-2141.

Research Administrator, 35–42, at least a BS in mechanical, chemical engineering, or applied physics, at least ten years' experience in applied research administration. Teaching at college level helpful. Knowledge of thermodynamics and fluid mechanics. Will assist in management of well-organized research lab. About $10,000. Ill. C-3574.

Industrial-Development Technician, 40–60 mechanical graduate, at least five years' experience in getting a variety of small businesses into production, including plant layout and tooling. Knowledge of varied manufacturing operations. Will establish and put into production a group of small mechanized businesses. In some cases advance planning has been done and in other cases this man will have to do all advance planning and organizational work. $9000, plus cost of living and expenses. India. C-3618.

Production Superintendent, about 30, chemical or mechanical engineer, process-plant experience, about five years' experience after graduation, and aptitude for process-plant operations and/or engineering supervision. Will engage in orientation program in general manufacturing as assistant to superintendent. Must be managerial prospect. $6600–$8000, plus moving expenses. Company will pay placement fee. San Francisco Bay area. S-197.

Development Engineers, to 50, mechanical engineers, some knowledge of chemistry, and ten to 15 years' experience, preferably in light industrial (plastic-metal combination) development-design. This involves manual valving of small pressurized containers used by the public. Will make basic investigations, conceive and develop ingenious, simple, and unique device; working with production, tooling, machining, and plant-engineering departments. Will do research, develop and test prototypes, report regularly to management, and follow-through to production; practical and costwise. $7000–$9000. San Francisco, Calif. S-466.

Candidates for Membership and Transfer in the ASME

The application of each of the candidates listed below is to be voted on after Oct. 25, 1955, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any Member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications

For Member, Associate Member, or Affiliate

Adams, C. Howard, Springfield, Mass.
Applebey, Edmund C., Pittsburgh, Pa.
Benzinger, Georg J., New York, N. Y.
Bigelow, Charles R., Wilmington, Del.
Birchler, Charles F., Cleveland, Ohio
Bourbonnais, Telesphore L., 2nd, Aiken, S. C.
Brown, Otto G., Austin, Texas
Bruch, Frederick E., Jr., St. Louis, Mo.
Burgess, John C., Menlo Park, Calif.
Cantrell, Harry N., Schenectady, N. Y.
Chute, Richard H., Wellsville, N. Y.
Clark, Earl K., Lake Jackson, Texas
Cline, Hubert S., Wilmington, Del.
Cole, Russell P., Woodside, N. Y.
Corrsin, Stanley, Baltimore, Md.
Davis, Stephen S., Washington, D. C.
Dean, Albert G., Narberth, Pa.
Delaplane, Frank, Halethorpe, Md.
Downing, Wilbur E., Baltimore, Md.
Duffus, Henry B., Pittsburgh, Pa.
Durante, Albert W., Camden, N. J.
Farley, Wilbur J., Woodstown, N. J.
Footlik, Irving M., Chicago, Ill.
Fortney, Ralph R., New York, N. Y.
Galloway, Donald F., Loughborough, England
Glazebrook, Thomas H. J., White Plains, N. Y.
Green, Allen P., Jr., Seattle, Wash.
Grossman, Irwin, Los Angeles, Calif.
Guillory, Horace J., Bunkie, La.
Haley, Basil L., Toronto, Ont., Can.
Hammarlund, George G., Springfield, Mass.
Hawkinson, Donald R., Emeryville, Calif.
Heldmann, Norman C., N. Augusta, S. C.
Johnson, Stephen, Jr., Elyria, Ohio
Jones, Arthur T., Houston, Texas
Jones, William E., New Orleans, La.
Kawecka, John J., Toledo, Ohio
Kibronski, John P., Cranston, R. I.
Knisely, J. Dan, Kirkland, Wash.
Koning, Hendrik B., Narberth, Pa.
Krajcovic, John, New York, N. Y.
Kurzweil, Robert, New York, N. Y.
Larson, Kenneth O., Springfield, Mass.
Lasek, Thaddeus A., Chicopee, Mass.
Levy, Joseph, Tel Aviv, Israel
MacDermod, Elliott, Ridley Park, Pa.
Machacek, Rudolph J., Chattanooga, Tenn.
Marshall, Charles C., Atlanta, Ga.
Matthews, James N., Toronto, Ont., Can.
Meyers, Dan, Berkeley, Calif.
Moyer, Richard L., Newark, Del.
Mumford, Eustace H., Ottawa Lake, Mich.
Nelson, Leonard C., Raleigh, N. C.
Orstett, Hjalmar N., Brooklyn, N. Y.
Prendergast, John R., Toledo, Ohio
Ram, Chandra S., St. Ignace, Mich.
Randall, Edward W., Northboro, Mass.
Reed, Ronald L., Milwaukee, Wis.
Rice, William T., Wilmington, Del.
Ridings, Alex, Jr., Harriman, Tenn.
Safford, Harrison H., Newark, N. J.
Schmidt, John W., Jr., Los Alamos, N. Mex.
Seide, Paul, Los Angeles, Calif.
Sheophoester, Kenneth F., Newington, Conn.
Sherland, Garfield S., Babylon, N. Y.
Simonson, Marvin R., Evendale, Ohio
Stevens, Joseph W., Playa Del Rey, Calif.
Strausbaugh, Gerald E., Toledo, Ohio
Ter Borg, Frederick M., Maracaibo, Venezuela, S. A.
Trudeau, Urban P., Toledo, Ohio
Trybus, Conrad A., Detroit, Mich.
Tuesca, William E., Barranquilla, Colombia, S. A.
Ulliv?rri, Mario Z., Oriente, Cuba
Ungar, J. Stephen, New York, N. Y.
Van Ness, Clair L., Cuyahoga Falls, Ohio
Viggers, Stuart T., Seattle, Wash.
Weber, Helmut E., Orinda, Calif.
Weddington, Robert L., Charlotte, N. C.
White, Walter H., Short Hills, N. J.
Whiteneck, Thomas L., San Diego, Calif.
Winston, Robert F., Lake Jackson, Texas
Woods, James J., Eddystone, Pa.
Worth, John S., Bethlehem, Pa.
Wright, Eugene R., Houston, Texas

Change in Grading

Transfer to Member or Affiliate

Addie, Albert N., La Grange Park, Ill.
Arscott, Joseph W., Maracaibo, Venezuela, S. A.
Bell, Charles R., Chicago, Ill.
Bolton, James A., Darien, Conn.
Brain, Jesse, Babylon, N. Y.
Brown, Robert G., Concord, Mass.
Carlson, H. Maurice, Louisville, Ky.
Claffey, Charles J., Knoxville, Tenn.
Dellacanonica, Oswald G., Lima, Peru
Evans, Thomas B., Ogden, Utah
Fletcher, Edwin H., Staten Island, N. Y.
Franklin, Burton P., Leaksville, N. C.
Friedlander, Walter H., Cincinnati, Ohio
Hall, Donald E., Kirkwood, Mo.
Hallam, Robert M., Springfield, Mass.
Holmes, Harlan T., Little Rock, Ark.
Hufford, Wayne P., Chicago, Ill.
Jack, David C., Jr., Pittsburgh, Pa.
Johnson, David W., Dover, Del.
Johnson, Samuel E., Jr., Schenectady, N. Y.
Kendall, Julius, Garden City, N. Y.
King, Lewis O., Grabill, Ind.
Kish, George D., Bradford, Pa.
Klaus, Albert J., Union City, N. J.
Knopp, Donald W., Peoria, Ill.
Kock, Paul O., Columbus, Ohio
Korner, Renzo L., Elmira, N. Y.
Lenardson, James D., Ottawa Lake, Mich.
Luster, Eric W., New York, N. Y.
MacKenzie, Frank C., Windsor Mills, Que., Can.
McDaniel, Benjamin H., Jr., Jacksonville, Fla.
Melton, James O., Norman, Okla.
Neff, Stephen H., Sidney, Ohio
Nordeen, Francis W., Bellevue, Wash.
Payne, Walter E., Fort Worth, Texas
Pitts, Lucius L., Rome, Ga.
Pounds, Truman E., Lake Jackson, Texas
Preisendanz, Edward S., Havertown, Pa.
Prusinski, Robert A., Beirut, Lebanon
Scheu, Edward P., Springhill, La.
Schmitt, James L., Washington, Ill.
Shires, Frank, West Hartford, Conn.
Stitzer, Donald J., Wilmington, Del.
Tessin, William, Arlington, Va.
Thackrey, James D., Pasadena, Calif.
Titus, James W., Washington, D. C.
Van Dongen, Dirk, Manila, P. I.
Vlachos, James N., New York, N. Y.
Warshal, Morris, Jersey City, N. J.
Westcott, John C., Schenectady, N. Y.
Wheless, Eakin L., Jr., Shreveport, La.
Wickham, Paul L., Long Beach, Calif.
Wolf, Herman H., Philadelphia, Pa.
Wortell, Marvin, Chicago, Ill.
Wydler, Hans U., Boston, Mass.
Zimmerman, Richard H., Columbus, Ohio

Transfers from Student Member to Associate Member 35

Obituaries . . .

Edward Robert Armstrong (1877–1955), of Monroeville, N. J., inventor of the seadrome, an oceanic floating airport, died July 6, 1955. Born, Mount Forest, Ont., Can., March 4, 1877. Education, graduate, Collegiate Institute, Guelph, Ont., Can. Mem. ASME, 1916. His creative work had much to do with overcoming the problems of buffeting by wind and wave and of deep-water anchoring. He solved the former by building his model drome on a series of posts supported on floats well below the wave level. The inventor held basic patents on many of the features of the seadromes. In the past few years his work had neared completion in the projected construction of floating platforms for maritime oil drilling.

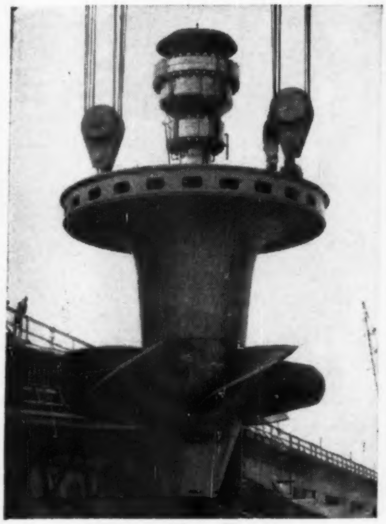
Wilburn Clegg Austin (1894–1955), contracting engineer, Industrial Piping Division, Grinnell Co., Inc., Atlanta, Ga., died Feb. 1, 1955. Born, Union County, N. C., Jan. 15, 1894. Education, BE(ME), North Carolina State College, 1920; special course, University of Toulouse, Toulouse, France. Mem. ASME, 1948. Survived by wife.

Fuller Forbes Barnes (1887–1955), president of Associated Spring Corp., Bristol, Conn., from the time of its organization in 1923 and chairman of the board of directors until his retirement in 1954, died June 18, 1955. Born, Bristol, Conn., March 6, 1887. Parents, Carlyle F. and Lena H. (Forbes) Barnes. Education, graduate, Philips Academy, Andover, Mass., 1906; AB, Yale University, 1910. Married Myrtle Aurelia Ives, 1913. Assoc. ASME, 1919. He was organizer of Bristol Hospital and its president from 1921 to 1951. He was a director of the Multiple Sclerosis Society and a director and vice-president of the Newington Home and Hospital for Crippled Children. He had been president of the Covington Trust at Yale and a director of the Bristol Clock Museum. He long had been active in many aspects of civic work in the State of Connecticut and, from 1929 to 1933, had served in the state senate. Survived by wife, a son, Carlyle F.; two daughters, Mrs. Paul W. Adams and Mrs. William S. Bristow; a brother, Harry; and eight grandchildren.

Isidor Chesler (1886–1955), director of research and development, Eagle Pencil Co., New York, N. Y., died July 21, 1955. Born, Slonim, Russia, June 20, 1886. Education, 3 years, Hebrew Technical Institute; electrical and engineering training at Cooper Union. Naturalized U. S. citizen, Newark, N. J., Dec. 22, 1920. Assoc-Mem. ASME, 1921; Mem. ASME, 1935. He had been a protege of the late Thomas A. Edison, Hon. Mem. ASME, and was associated with the inventor for several years in a number of research programs and experimental projects. Between 1910 and 1914 he worked with Mr. Edison on the latter's research on electric storage batteries and in 1917 he served with the inventor on the development of electrical devices for detecting enemy submarines and torpedoes. He was one of the first men to apply scientific research to the improvement of the lead pencil. He developed a process for taking the brittleness out of colored leads. From 1914 to 1916 Mr. Chesler

(*ASME News continued on page 954*)

3 TYPES of Hydraulic Turbines

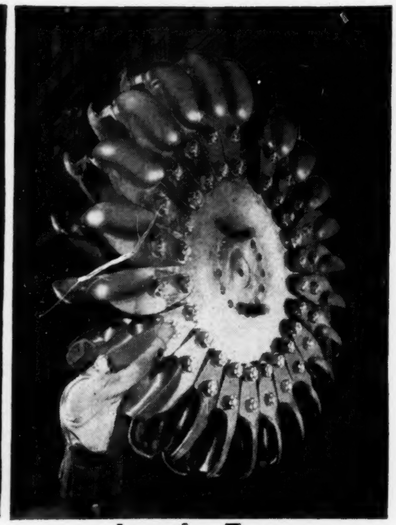


Propeller Type

Regularly chosen for low heads, up to 100 feet normally, and in exceptional cases even higher. Its higher speed effects appreciable savings in generator cost.

Francis Type

Used for heads up to 1000 feet — in some cases even higher heads — depending on the output capacity of the unit, the quality of operating water, and the character of load to be carried.



Impulse Type

For heads as high as pressure pipe lines can be built. Used for heads as low as 200 feet if water conditions prevent use of Francis type because of excessive wear.

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Over 14½ million installed horsepower of hydraulic turbines throughout the world.

worked for the L. E. Myers Co. of Chicago, Ill., supervising the installation of mechanical and electrical devices used in a model of the Panama Canal shown at the Panama Pacific International Exposition in San Francisco, Calif. This work won him the gold medal of the exposition's International Jury of Awards. While with the Eagle Pencil Co., he patented a number of mechanical and chemical ideas. He also invented devices for making accurate measurements of the characteristics of leads. Survived by wife, Belle; a daughter, Mrs. Elinor Boyd, New York, N. Y.; a son, Norman P., San Francisco, Calif.; three grandchildren; four brothers; and a sister.

Martin L. Katzenstein (1879–1955), founder and president, Warren Engineering Co., New York, N. Y., died July 21, 1955. Born, New York, N. Y., Aug. 18, 1879. Parents, Leopold and Sarah (Hecht) Katzenstein. Education, BS, City College of New York, 1900; ME, Cornell University, 1902. Married Hattie Neuman, 1908 (died 1943). Jun. ASME, 1903; Mem. ASME, 1915. Survived by daughter, Mrs. Ruth Reiss; two sons, Robert Kay, Martin L. Kay; a brother, William; a sister, Mrs. Frieda K. Sternberg; and five grandchildren.

Ernest Frederic Mercier (1878–1955), whose accomplishments in the fields of electric power, mechanical and electrical engineering, petroleum development, management, finance, and international relations have been outstanding, died in Paris, France, July 11, 1955. Born, Constantine, Algeria, Feb. 5, 1878. Education, primary and secondary studies at Lycee de Constantine, Baccalauréat of Letters and Sciences, 1895; superior studies at Lycee Louis-le-Grand, Paris, as student of special mathematics, 1896-1897; l'Ecole Polytechnique, 1899. Delegated by the Ministry of the Navy to l'Ecole Superieure d'électricité, engineer with diploma, 1905. Upon leaving l'Ecole Polytechnique he entered the Naval Engineering Corps as engineer in 1899, where he remained until 1912 when he resigned to enter industry. He was employed as chief engineer of Societe "Le Triphase" to put in effect the modernization and extension of the power plant of the company at Asnieres (Seine). During the first world war he volunteered for combat duty and was twice promoted in the Legion d'Honneur for his distinguished war deeds. A Grand Officier of the Legion, after the liberation of France, he was named a member of the Counseil de l'Ordre. When he was made an Honorary Member of ASME in 1955, it was said of him as follows:

"In reviewing the achievements of Ernest Frederic Mercier it is difficult to believe that so many careers could have been so successfully crowded into one lifetime. Upon completing his studies at the Polytechnic School in Paris, 1899, he spent 13 years as an engineer in the French Navy. Resigning to enter industry, he was not only responsible for organizing and maintaining the power industry in France but also played an important role in the petroleum and mechanical-construction fields.

'Two world wars have claimed from him ten years of outstanding service. During the past 20 years he has headed a number of international professional organizations. In addition, he has found time for educational work as well as research and experimentation in thermodynamics and the gas turbine.

"Prior to World War I Mr. Mercier was chief engineer of the 'Triphase' Company and modernized its power plant at Asnieres (Seine). Before leaving the Ministry of Armament after the war he mapped the program for reorganizing the nation's electrical production and distribution. In 1919 he founded the Union d'électricité, which constructed the Gennevilliers power plant, the first large interconnecting power system in the Paris area, as well as the Arrighi power plant. His activity in hydroelectric development continued despite the difficulties of World War II and he participated in many other power projects in France and abroad until nationalization of these utilities in 1946.

"In 1919 Mr. Mercier founded the French Petroleum Company of which he was president and was also director of the Irak Petroleum Company, London, England, until the Vichy Government withdrew these appointments. In the mechanical-construction industry he has been administrator of the Alsatian Company, the Alsthom Manufacturing Company, and the Penhoet Shipyard and Manufacturing Company. He has been a director of the Suez Canal Company since 1946.

"International organizations he has headed include the French National Committee of the World Power Conference, and the French Committee of the International Chamber of Commerce. A native of Constantine, Algeria, in 1878, he has received numerous honors and awards in France and abroad for his contributions in war and peace."

Robert John Morgenroth (1899–1955), retired, chief engineer, Christiana Machine Co., Christiana, Pa., died July 6, 1955. Born Newark, N. J., Aug. 14, 1899. Parents, Ernest and Anna E. (Ludwig) Morgenroth. Education, BS(ME), Newark College of Engineering, 1925. Married Annabelle Virginia Marsh, 1928; son, Robert M., 2nd Lieut., MacDill AFB, Fla. Jun. ASME, 1925; Mem. ASME, 1934.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions' enrollment are correct. Please check whether you wish mail sent to home or office address.

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Publication	*Address changes effective when received prior to:*
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☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

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